III.—Note on the foregoing List of Cyclones, and on the Gujarat land-cyclone of July 11th-13th, 1881, by HENRY F. BLANFORD, F.R.S., *Meteorological Reporter to the Government of India.*

The foregoing list of storms, that have been felt on the west coast of India, appears, in some respects, to be more comprehensive than that to which Mr. Chambers refers at his model, *viz.*, my own list of cyclonic storms in the Bay of Bengal, published in Volume XLVI of the Journal of the Asiatic Society of Bengal, (for 1877); and as the two lists are likely to be compared, with a view to elucidating points of resemblance or difference between the two regions respectively dealt with, it seems desirable that I should point out wherein they differ in character. I wish, also, to add some details respecting the last storm in Mr. Chambers' list, which, in certain respects, is unique in my experience of cyclonic storms, and which is of great importance to the study of the genesis of cyclones, having been formed over a land area surrounded by observatories. The list contains, however, others which, as I shall presently point out, were very probably of the same character.

The object with which my own list of recorded cyclones in the Bay of Bengal was drawn up, was stated to be that of "ascertaining with greater accuracy than had previously been practicable, what is the distribution of cyclones at the different seasons of the year; and also what parts of the Bay are most liable to storms in each season of the year." The list, therefore, included only cyclonic storms which had raged in the Bay of Bengal; or, if recorded only at coast stations, were of such character, as to admit of little reasonable doubt that they had been generated over the Bay: and such land-formed storms as the nor-westers of the spring and summer months, notwithstanding that the wind pressure in such storms frequently attains to cyclonic strength, (pressures of 30 lbs. to the square foot having been recorded in these storms, more than once at Calcutta), were rigorously excluded.

Mr. Chambers' object and rule of selection have been somewhat different. In addition to storms that have been experienced on the Arabian Sea, he desired to obtain record of those which have been felt on the west coast of India, and which appear to have been cyclonic in character, without regard to the place of their origin. This included some, respecting which, there can be little or no doubt, were formed over the land. The most recent and conspicuous example is that of which I shall presently give a more detailed account. But there are others probably of this character, which, in some cases, they occur at a season to believe that cyclones are practically unknown as storms, the only record of which is that afforded by the

annual epochs of maximum frequency in July and August 1881. But there are others probably of this character. amer monsoon is the epoch distinguish these, because, in some cases, they occur at a the Bombay coast, it is the season to believe that cyclones are practically unknown as storm production. At both obvious that, in working the storm-warning system, the Bombay than on the Bengal and the path followed by storms are points of primary i storms, the only record of which is that afforded by the

to apply to distinguish land-formed storms from those which approach from the sea. (first) from the south-west or south in the case of the Bombay coast, viz., the direction of the wind at the beginning of the storm. A consideration of the well-known law of spiral winds in cyclonic storms will indicate that, in storms of the latter class, the wind will probably begin from some quarter between north-west and south-west on the coast of the peninsula, between north and east on that of Sind, Cutch, and Gujarat; from which it will veer or back, accordingly as the path of the storm is to north-west or southward of the observatory. Now, applying this test to the storms recorded by Mr. Chambers, the following are almost certainly to be excluded from the list of sea-formed cyclones:—

No. 8, *November 17th to 18th, 1874*.—Strong gale from north off Cape for thirty hours.

" 42 " *22nd, 1875*.—Gale at Porbandar from north-west. Maximum pressure 12·25 lbs. per square foot. Cyclonic depression of barometer moved from north-west to south-east.

" 55. *January 17th, 1877*.—Gale at Porbandar from south. Maximum pressure 9 lbs. per square foot. Strong wind at Kurrachee. Maximum velocity 40 miles per hour. Cyclonic depression of barometer at Porbandar and Kurrachee.

" 57. *February 6th, 1877*.—Gale at Kurrachee from west. Maximum velocity 41 miles per hour. Strong wind at Porbandar, also from west. Cyclonic depression of barometer also at Kurrachee and Porbandar.

No. 58. *March 28th, 1878*.—Gale at Kurrachee from west. Maximum velocity 43 miles per hour.

" 62. *July 19th, 1876*.—Gale at Kurrachee from south-west. Maximum velocity 42 miles per hour. Strong wind at Porbandar from south-south-west. On 18th maximum pressure 9·05 lbs. per square foot, accompanied by a cyclonic depression of the barometer and 7·20 inches of rain.

" 70. *July 19th—20th, 1881*.—Cyclone in Cutch and Kathiawar. Cyclonic depression of barometer at Bhuj and Rajkot. At Jamkandorna 18½ inches of rain are said to have fallen during the storm.

This last is the storm, the history of which I shall presently give, and which may probably stand as a type of many other storms in the list. And the following, though their exclusion is less certain, seem to me of very doubtful validity as sea-formed cyclones,—

No. 21. *June 24th—30th, 1845*.—Gale at Bombay from west. Maximum pressure of the wind 9 lbs. per square foot, accompanied by a slight barometric depression.

" 33. *May 8th, 1851*.—Gale at Bombay from south-south-west. Maximum pressure of the wind 10 lbs. per square foot. Slight depression of barometer.

" 37. *June 11th, 1852*.—Gale at Bombay from south-south-west. Maximum pressure of the wind 10·75 lbs. per square foot.

" 51. *August 1st, 1875*.—Gale at Porbandar from west. Maximum pressure of wind 12·25 lbs. per square foot.

" 52. *September 16th, 1875*.—Gale at Porbandar from south-west. Maximum pressure of wind 10·25 lbs. per square foot. Slight fall of rain fall. Cyclonic depression of barometer.

" 63. *July 19th, 1876*.—Gale at Kurrachee from south-west. Maximum pressure of wind 10·75 lbs. per square foot.

" 64. *August 19th, 1876*.—Gale at Porbandar from south-south-west. Maximum velocity 47 miles, at which time Porbandar, Deesa, and Kurrachee, where maximum pressure was 9·05 lbs. per square foot respectively, were recorded. Winds, more west and southward at Belpauri, Deesa, and Porbandar, south-west to west-south-west at Kurrachee. Slight barometric

Now, of the storms, which, judged by the test of wind direction, should, I consider, certainly be excluded from the list of those generated over the Arabian Sea, one occurred in January, three in February, one in March and two in July. Five of these occurred at the season, when cyclonic storms are least frequent (in February unknown) in the Bay of Bengal, and when we may reasonably expect them to be equally rare in the Arabian Sea. All but the first (that of February 1701), are unquestionably instances of storms formed in the low-lying plain that extends between the Aravali Chain and the mountains forming the western frontier, the plain of Western Rajputana, Northern Gujarat and Sind. The other two are the two July storms of the list, and were, in the one case certainly, in the other probably, formed in the same region.

Of the six storms in the doubtful list, one is a January storm, respecting which, no other information is given, than that the force of the wind attained to a pressure of 12·2 lbs.; a pressure far surpassed by many an ordinary nor-wester squall. But as it may be inferred from Mr. Chambers' introductory remarks, that the strong wind was not merely temporary, but lasted for some 24 hours, it seems probable that this storm was of the same class as the January and February storms of the first list of exclusions. The others occurred, one in May, three in June, and one in August. Four of these may have been the result of local eddies, accompanying the first burst of the monsoon, such as frequently occur both at this period, and also during the monsoon months, on the coast of Orissa and the Sunderbuns. And the August storm, No. 49, recorded at Deesa, was probably of the same type as the two July storms of the former list.

Excluding these storms, Mr. Chambers' list, classified according to the months, will be as follows:—

January	February	March.	April.	May.	June.	July	August.	September.	October	November.	December.
2	0	1	0	12	17	0	1	3	4	10	2

which accords much more nearly with the list of Bay of Bengal storms, given in the *Vade Mecum*, than the more comprehensive summary given by Mr. Chambers. The Bay of Bengal list is as follows:—

January	February	March	April	May	June.	July	August.	September	October	November.	December.
2	0	2	9	21	10	3	4	6	31	18	9

The two lists accord then, in the fact that there are two annual epochs of maximum frequency, *viz.*, May and June, and October and November, an absolute freedom from cyclones in February, and a secondary period of minimum frequency in July and August. But whereas, in the Bay of Bengal, the close of the summer monsoon is the epoch of the absolute and a very preponderant maximum, on the Bombay coast, it is the beginning of the monsoon which enjoys the supremacy of storm production. At both epochs, too, the maximum falls a month later on the Bombay than on the Bengal side.

It is very possible that, among the storms in Mr. Chambers' list, which I have provisionally admitted as Arabian Sea cyclones, a few might prove inadmissible were more detailed information forthcoming; but it is unlikely that their exclusion would greatly alter the general features of the result.

In the category of land-formed storms, I do not include that important class of cyclonic storms, which, being originally formed over the Bay of Bengal, travel on a westerly or north-westerly course to the Madras or Coromandel coast, and apparently crossing the peninsula, reappear on the opposite coast. I say *apparently* crossing the peninsula, for it is extremely doubtful whether in the majority of instances, perhaps in any case, a vortex formed over the Bay of Bengal ever really crosses the peninsula.* The experience gained from the study of such cyclones of this class as have occurred in recent years is, that vortices which cross the coast line, in the southern part of the peninsula, are only traceable, as such, as far as the hills of the Eastern Ghats. On meeting the high lands of the interior, they are broken up, but are reformed on the west coast, and thence, in certain cases, pursue their north-westerly course across the Arabian Sea. In certain cases, it is possible that, instead of passing away from the coast on a north-westerly course, they run up the coast towards Kathiawar, and are thus felt successively at all the ports of the west coast. Such, according to Mr. Chambers, was the case of the storm of the 21st to 26th May, 1879, (No. 67 of the list). But so little has hitherto been published bearing on the study of storms on the west coast of the peninsula, that this and many other points must be left for future determination.

An excellent illustrative case of one of these storms is that which was formed off the coast of Ceylon, on the 11th November 1881. This vortex reached the Coromandel coast, crossing it between Madras and Negapatam, on the morning of the 13th, and by 10 A.M. of that day, the centre lay not far to the west of Madras, moving apparently on a north-west course. At the same hour, a new vortex was forming on the west coast, immediately to the south of Goa; and on the afternoon of the same day, was felt with some little severity at the ports of the Southern Concan and Malabar. A weather chart of the peninsula, at 10 A.M. of the 13th November is given in Plate X. In this case, the simultaneous existence of the two vortices is demonstrable, owing to the fact of their occurring at one of the regular hours of observation at Indian observatories. This of course may not always happen.

It is still a question whether, even in the cases of the foregoing description, storms cross the peninsula, from that part of the coast running to the north of the Godavery delta. That they do not always follow this course, even after striking the coast of the Carnatic south of the Kistna, is proved by the instance of the cyclone of the 16th—22nd May 1877, which reached the Madras coast near the mouth of the Pennair River, on the night of the 18th May, and then passed up the line of the Eastern Ghats to Orissa, and thence inland to Behar and Northern Bengal.

There is, however, another class of storms, generated on the coast still further north, which pass inland, traversing a great part or even the whole length of Northern India,†

* [illegible]

† [illegible]

and which occasionally, though rarely, may possibly have a certain connection, at least as precursors, with the land-formed storms of Gujarat. These are the cyclones of the summer monsoon, to which Mr. Eliot has drawn attention in the first memoir of this volume, and which, in some years, are formed, in frequent succession, in the north-west corner of the Bay of Bengal. The barometric depression in these storms is very small, scarcely ever exceeding 0·2″ or 0·3″; the central depression is generally many miles, sometimes more than one hundred miles across, and the winds around are, as a rule, moderate; but they are often accompanied with heavy rain, and are very persistent. Their most ordinary course is about WNW. or W by N. It was one of these storms, in September 1880, that led up to the deluge of rainfall in Rohilkhand and the Almora hills, that produced the catastrophe of the Naini Tal landslip; and another was the precursor, with an interval of some days, of the Gujarat storm of July 1881. This I shall presently notice at more length, and will now return to the consideration of those of the Bombay coast.

Of storms probably formed over the Arabian Sea, in the neighbourhood of the Lakhadives, or between those islands and the Indian coast, and which, travelling to the east of north, are felt severely on the coast of Bombay or Kathiáwar, we have no further information than a few meagre references in Piddington and other writers. They are probably of rare occurrence, and constitute but an insignificant proportion of the storms of the Arabian Sea, if we may judge from the analogy of the Arakan coast and the storms of the Bay of Bengal.

The land-formed storms of Western Rajputana and Gujarat fall naturally into two classes; those of the cold season, and those of the summer monsoon. To the former belong the five storms Nos. 42 (probably 51), 55, 57 & 58 of Mr. Chambers' list; to the latter, in all probability, Nos. 49, 62, and with absolute certainty, as a typical example, No. 70. It is very likely that Nos. 44 and 54, and possibly No. 13, should also be included in this latter category, but the data are insufficient to determine the point in a satisfactory manner, and I have therefore not enumerated them in my list of exclusions from the marine storms.

The storms of the first class are phenomena of the winter rains of Northern India. The cases of cold-weather rainfall that have been discussed in the Reports on the Meteorology of India in 1878, 1879 and 1880, afford several instances of local barometric depressions, being formed in the plain region to the west of the Aravalis; most frequently perhaps in Sind and the adjoining portion of the Bickaneer desert. Such were the barometric minima formed between the 22nd and 23rd January 1878, on the 24th December 1879, and February 8th, 1880. Indeed, the general result of these discussions has been to shew that, the cold-weather rainfall usually begins on the northern margin of a barometric depression, which first appears in this region; the rain beginning in the Punjab, and afterwards extending to the North-Western Provinces, and sometimes to Bengal, as the depression moves eastwards. Indeed, on considering the fact, that the plateaux of Central India and the Central Provinces are normally a region of high pressure during the winter months, the tendency to high pressure here, in the heart of India, being more persistent than even in the Punjab and Sind, (where the pressures, though occasionally much higher, are interrupted by greater oscillations); it is easy to see that, in accordance with the law of wind circulation around barometric maxima, there must

for recent years, show that, as above, there is usually a region of low relative pressure around the Gulf [illegible] cold season of 1880-81. [illegible] That the barometric [illegible] wind pressures and [illegible] which, if previously [illegible]

The conditions which lead to the formation of cyclonic storms in this region in the summer monsoon, are very different. The storm of the 11th—13th July 1881 is the only instance that has yet been studied in detail; but it may, in all probability, be taken as typical of this class of storms. I shall therefore describe it fully, reviewing, in the first place, the conditions antecedent to its genesis.

Cyclonic storm in Gujarat of the 11th—13th July 1881.

The monsoon rains set in on the Bengal side of [illegible] the first week of June. On the Bombay side, [illegible] some rain fell during June, the western branch of the [illegible] interior of the country, in force, until the end of the month. And the Bengal branch after bringing more or less rain to the whole of Northern India, (except the region west of the Aravalis), between the 8th and 15th, fell off [illegible] followed by nearly a fortnight of dry weather with [illegible] Provinces, lasting until the 25th or 26th of the month [illegible] the monsoon was reported to be fairly established on both coasts.

During the rainfall of June, the trough of low pressure which runs across Northern India in the monsoon months, dividing the western or Bombay from the eastern or Bengal branch of the monsoon, lay well to the south of the Ganges and Jumna. In the beginning of July also, it most frequently hel[illegible] 7th, and again after the 9th. On the 2nd of [illegible] to which reference has already been made, [illegible] of the rainy season, appeared on the coast of Orissa; and, on the 3rd and 4th, advanced westward, along the barometric trough between the two branches of the monsoon; its centre reaching Sambalpur on the 3rd, and Seoni on the forenoon of the 4th. On the 5th the vortex was still traceable in the neighbourhood of Gaya, but the local barometric depression had almost disappeared; and on the 6th, completely so, being merged in the trough, which, on this day, extended almost in a straight line from Peshawar to Calcutta. The pressure at Jaunpur had, [illegible] Benares.

Up to the 9th, the seat of lowest pressure had been generally in the Punjab, chiefly at Peshawar, and in the Derajat; but, on one or two occasions, when rain fell in the Punjab, the barometer had risen, and more especially at Dera Ismail Khan and Mooltan, producing a local maximum over one or both of these stations. Such was again the case on the 10th of July, after two days of extraordinarily heavy rain, in the Punjab, Rajputana and Central India, and the western districts of the North-Western Provinces.

The following falls, registered in these provinces on the 8th, 9th and 10th July, will afford some idea of the unusual copiousness and extent of this rainfall :—

	8th	9th	10th	3 days' Total.		8th.	9th	10th.	3 days' Total
Lahore	—	1·65	5·05	6·70	Bhopal	2·85	0·78	0·45	4·08
Amritsar	0·30	3·90	5·60	14·80	Sutna	—	3·36	0·38	3·74
Jullunder	0·70	—	7·30	8·00	Nagode	—	2·40	1·00	3·40
Hoshyárpur	3·50	—	7·00	10·50	Rewah	0·25	0·36	3·65	4·26
Ludhiana	0·40	—	6·00	6·40	Dera Dun	1·47	1·25	0·05	2·77
Umballa	1·10	1·90	0·70	3·70	Saharanpore	2·50	0·20	0·80	3·50
Delhi	4·45	0·61	1·30	6·36	Bulundshahr	4·00	—	0·20	4·20
Bickaneer	4·28	0·18	0·05	4·46	Bareilly	0·91	4·11	—	5·02
Bhurtpore	—	2·88	0·18	4·06	Agra	—	3·40	0·80	4·20
Jeypore	—	2·19	1·36	4·55	Mainpuri	—	2·30	0·30	2·60
Delhi	—	4·80	0·04	4·84	Etah	—	4·50	0·20	4·70

On the forenoon of the 10th, over nearly the whole of extra-tropical India, the barometer, reduced to its sea-level value, indicated a pressure of less than 29·6″. The isobar of 29·6″ ran from Rawalpindi, almost in a straight line to the Ganges, a little west of Patna, thence to the north of Berhampore, and curving to the south through the middle of the Gangetic delta, and enclosing the western half of the delta and the north-west corner of the Bay, intersected the coast line near Gopalpur, and returned westwards, between Seoni and Nagpore, to Hoshangabad; whence it followed the course of the Nerbudda, to the Gulf of Cambay. Within this area, the differences of pressure were small; but, along its axis, were ranged three, or perhaps, two local depressions, in which the pressure was below 29·55″, and which were therefore the regions of minimum pressure in India. The westernmost and largest of these included nearly the whole of Rajputana, Upper Sind, Cutch and Northern Gujarat; the lowest pressures within which, were Ajmere 29·526″, Bickaneer 29·524, and Jacobabad 29·534″ (reduced to sea level values). The next comprised a small area around Saugor, at which the reported reading (reduced to sea-level) was 29·512″. This, however, is not quite certain, as the readings of the Saugor barometer are not very trustworthy. Moreover, the depression, the existence of which is further indicated by the barometer readings to Nowgong and Jhansi, may possibly have been not independent, but an extension of that of Western Rajputana. The third centered at Saugor Island in the Sunderbuns, where the barometric reading was 29·504, the lowest recorded in that day; and the depression included Calcutta and apparently extended some distance to the north-west in the direction of Hazaribagh.

Within and around the great western depression, the concentration of which subsequently gave birth to the Gujarat cyclone, the winds, at 10 A.M. of the 10th, were NNW. at Pachbudra, NNE. at Bickaneer, N. at Ajmere, calm at Sirsa, E. at Agra, Allahabad and Benares, calm at Jhansi and Nowgong, NE. at Sutna, W. at Jubbulpore, and SW. at Saugor, NW. at Pachmarhi and Seoni, SW. at Indore, Neemuch and

The barometric changes, in the previous 24 hours, consisted in a rise of pressure in the Indus valley, greatest at Mooltan; and a slighter rise throughout the Punjab and in Northern Rajputana. In Kathiáwar and Cutch, the change was insignificant. But at Pachbudra, Deesa, Surat, Malegaon, and to the eastward, in Berar and Nimar, there was a considerable fall; the result being the production of a local minimum between Pachbudra and Deesa. It was however a very slight depression, as far as is shewn by the registers; and although the winds of Pachbudra, Ajmere, Neemuch and Deesa were distinctly cyclonic around it, they were very light in the neighbourhood of the minimum. Only to the south and west, at Surat, Rajkot, Bhuj and Kurrachee, the monsoon current from the Arabian Sea blew strongly: and only at Bhuj, did even this current exceed the average velocity of the month.

On this day and hour then, the vortex was in process of formation, but, as yet, there was scarcely such a disturbance as to give rise to a wind of stormy violence.

A question, of much interest, which presents itself in connection with the generation of this storm, is whether the barometric changes which apparently caused the concentration, in the neighbourhood of Deesa, of the previous extensive and nearly equable depression, *viz.*, the rise in the Indus valley and on the north, and the fall in the area of Deesa, Surat, Malegaon, &c., can be traced back to any pre-existent conditions shewn by the registers.

As regards the former of these phenomena, *viz.*, the rise of pressure under the western hills, I have already observed that, on one or two occasions previously, a fall of rain in the Punjab had been followed by a rise of pressure in the Derajat and at Mooltan; and that the rise on the 10th (of which the further rise on the 11th was merely the prolongation,) was another instance of the same kind; and followed on the unusually heavy rain in the Punjab, (and other Provinces) of that and the two previous days. What may be the precise causal sequence of the phenomena, the physical connection of rainfall in the Punjab with a subsequent rapid rise of pressure in the Indus valley, is a question, which, at present, we are hardly in a position to answer satisfactorily; but that there is such a connection is, to my mind, amply established on an empirical basis, by the frequency of the sequence at all seasons of the year, and most strikingly, perhaps, in the case of the cold-weather rainfall.*

We may, then, regard the rise of pressure in the Indus valley and the Punjab, as a probable consequence of the unusually heavy rain of the 8th, 9th and 10th, and the northerly winds of the Indus valley and Northern Rajputana as the result of the difference of pressure, thus established, between the Punjab and the depression already existing in Western Rajputana and Northern Gujarat.

On the 11th, scarcely any rain fell in the Punjab and Sind, but it was still general in Rajputana, Central India, the Central Provinces, Cutch and Gujarat, as well as in the Konkan and Khandesh, and was especially heavy at certain stations in Kathiáwar, Surat, Broach, and the eastern districts of Gujarat. It had indeed fallen continuously, in this region, for several days; and as, at some stations, it had also been very heavy on the

* See, for example, the Report on the Meteorology of India in 1878, pp 129, 130, Report for 1879, pp. 136 and 154, and Report for 1880, pp. 143, 144 and 171. In the Report for 1880, pp. 170, 171, the probable physical connection of the phenomena in question is briefly discussed.

10th, the day which immediately preceded the formation of the vortex, I give the rain fall of that day alone. *

Rainfall (in inches) on 10th and 11th July.

Province	Station	Rainfall 10th	Rainfall 11th	Rainfall Total	Direction of Wind 10th
Konkan	Bulsar	0·01	1·50	1·51	E by S
	Surat	0·03	1·25	1·28	NE
	Broach	0·20	0·85	1·05	NE
	Ahmednagar	1·05	1·47	2·52	ENE
	Godhra	0·24	0·16	0·40	NNE
	Panch Mahals	—	0·07	0·07	E
	Nasik	0·05	0·13	0·18	NE
	Poona	0·15	0·09	0·24	ENE
	Satara	0·03	0·01	0·04	ENE
	Sholapur	0·04	1·39	1·43	ENE
	Khandesh	0·05	0·07	0·12	E
	Nagpur	0·06	0·06	0·12	ENE
	Chanda	0·03	0·22	0·25	SE
	Kathiawar	0·10	0·04	0·14	SE
	Baroda	0·13	0·13	0·26	SE
	Deesa	0·15	0·06	0·21	SE
	Kaira	0·04	0·02	0·06	ESE
	Ahmedabad	0·01	—	0·01	E by S
Deccan	Dharwar	0·03	0·08	0·11	E by S
	Belgaum	0·14	0·12	0·26	ESE
	Kaladgi	0·07	0·01	0·08	E by S
	Sholapur	0·01	0·01	0·02	E by S
	Poona	0·03	0·01	0·04	E by S
	Nasik	0·01	0·01	0·02	E by S
	Satara	0·01	0·01	0·02	E by S
	Ahmednagar	0·01	0·01	0·02	E by S
	Khandesh	0·01	0·01	0·02	E by S
Carnatic	Dharwar	0·01	0·01	0·02	E by S
	Belgaum	0·01	0·01	0·02	E by S
	Kaladgi	0·01	0·01	0·02	E by S
	Sholapur	0·01	0·01	0·02	E by S
	Poona	0·01	0·01	0·02	E by S
	Nasik	0·01	0·01	0·02	E by S
	Satara	0·01	0·01	0·02	E by S
	Ahmednagar	0·01	0·01	0·02	E by S
	Khandesh	0·01	0·01	0·02	E by S

From the above it appears that, on the 10th, the region of heaviest rainfall was an interrupted band ranging from north-east round to south of the site occupied by the depression on the forenoon of the 11th, the heaviest falls being at Beawar, Idar, Deesa and Erinpura, and, as appears from the table at the end of this paper, at certain stations in Kathiawar, Surat, and the Panch Mahals (east of Baroda). This does not coincide with that in which the chief barometric fall between the 10th and 11th took place, although it lay partly within it. Neither does this latter region coincide with that in which the movement of the air was greatest, nor that in which the greatest increase of movement took place, since, at Pachlana, where the average movement was but 8 miles an hour, and at Khandwa, where it was calm, the fall was in the former case half as great, in the latter more than half as great as at Mahegaon, where the movement was over 30 miles in the hour, having been above 6 miles on the previous day at 10 A.M.; while there was no fall of pressure at Rajkot, where it had increased from 10 to 38 miles an hour.

The area within which the barometer fell, was limited to a circumscribed portion of Northern and Western India, and is marked by a dotted line on the chart, Plate XI. Within this, there were apparently two independent areas of maximum fall, the one chiefly in the Gangetic plain, defined by Durbhanga, Patna, Gorakhpur, Allahabad, Lucknow, Bareilly, and Meerut, and, to the south of the river, Nowgong; the other, partly in the peninsula and partly in Western India, and including Hyderabad (Sind), Deesa, Pachbudra, Surat, Malegaon, Khandwa, Buldana, Sholapur, and Secundetabad, and centering at Malegaon. At Deesa, Surat, Malegaon, Buldana and Sholapur, the fall exceeded ·04". The fall in the 24 hours, from 10 A.M. of the 10th to 10 A.M. of the 11th, was as follows:—

Northern area of maximum fall.

	Fall.		Fall
Durbhanga	—·035 ins.	Nowgong	—·080 ins
Patna	—·030 „	Lucknow	—·032 „
Gorakhpur	—·035 „	Bareilly	—·027 „
Allahabad	—·041 „	Meerut	—·034 „

South-Western area of maximum fall.

	Fall.		Fall.
Hyderabad	—·024 ins.	Khandwa	—·033 ins.
Pachbudra	—·029 „	Buldana	—·044 „
Deesa	—·043 „	Poona	—·026 „
Surat	—·044 „	Sholapur	—·044 „
Malegaon	—·050 „	Secunderabad	—·030 „

All around this area, except (as far as is known) in the Himalayan region, to the north of the Gangetic plain, the barometer rose The greatest rise was in the Indus valley and in the south-west of Bengal, where the changes were as follow:—

Indus valley. Barometric Rise.		*Lower Bengal.* Barometric Rise	
Dera-Ismail-Khan	+ 040 ins.	Cuttack	+ ·037 ins.
Mooltan	+ ·055 „	Saugor Island	+ ·072 „
Jacobabad	+ ·048 „	Calcutta	+ ·052 „
Kurrachee	+ 032 „	Burdwan	+ ·023 „

That these changes of pressure, though small, had a certain significance as a part of the phenomena that determined the formation of the vortex, there can be little or no doubt; but it is not easy to correlate them, except partially and imperfectly, with the other circumstances of the local meteorology; and it is highly improbable that either the fall of pressure over the circumscribed area above defined, or the rise of pressure around its borders, is directly referable to any single elementary change of condition in the region affected.

Assuming that all changes of atmospheric pressure, whether due to static or dynamic causes, may be traced back to changes of static pressure, and that, of the causes producing changes of static pressure, the changes of atmospheric density, due to variation of temperature, are by far the most efficacious, the question remains, whether the higher or lower strata of the atmosphere are the seat of any given action of the kind. If the former, the most important agent indicated by physical considerations is the substitution of a saturated and condensing mass of air, for one which is dry and non-condensing; and which, in ascending as a continuous current, displaces cooler and

It appears then, that as regards the Deccan the fall of pressure between the 10th and 11th may have been partly due to the increase of temperature, indicated by the latter stations of the above list. But as regards Gujarat and Surat with the neighbouring region to the east and south-east, the fall of pressure was accompanied with a very marked fall of temperature; and as it was an area of excessive precipitation, in the absence of any other apparent agency competent to produce this local reduction of pressure, we may attribute it, with some probability, to the active condensation going on in the higher strata of the atmosphere The result was a great increase in the strength of the westerly monsoon, which fed the rainfall; and this, in accordance with the principle above laid down, determined a fall of pressure immediately to the north, and a transfer of the pre-existing minimum to the more southerly position which it occupied at 10 A.M. of the 11th, and which is shewn on the chart, Plate XI. The increase in the strength of the monsoon current, across Kathiáwar, Surat and Khandesh, and its simultaneous decrease in Cutch, are shewn in the following table, in which the rate of movement in miles per hour, at the hours of observation, 10 h. and 16 h. are given, as computed from the total movements recorded in the intervals. As these are alternately periods of 18 hours and 6 hours, on the assumption that the total distances indicated by the anemometer, when divided by 18 and 6 respectively, give the velocity at the middle of each period, the rate at 10 hours is computed by adding the mean velocity of the preceding 18 hours to three times the mean velocity of the succeeding 6 hours, and taking one-fourth of the sum. In like manner that for 16 hours is obtained by adding three times the mean hourly movement of the preceding 6 hours to that of the following 18 hours, and dividing by 4. This method of computation, although rough, probably gives an approximation sufficient for the present purpose. For Deesa, unfortunately, the anemometric data are wanting. Those for Bombay are taken from the traces of the Beckley's anemograph at the Colaba Observatory, and are actual rates :—

Computed wind velocity miles per hour.

Stations.	10th July				11th July			
	10 h		16 h.		10 h.		16 h	
	Dir.	Vel	Dir	Vel	Dir.	Vel	Dir.	Vel
Kurracheo	SW	21	WSW	23	W	24	WSW	25
Bhuj	WNW	46	SW	50	WNW	23	W	22
Rajkot	WSW	10	SSW	13	W	19	WSW	21
Surat	SW	10	SW	18	SW	35	SSW	37
Malegaon	W	7	WSW	6	W	32	W	33
Bombay	SW	24	WSW	34	W	29	W	30

Up to the evening of the 11th, the barometric depression was but slight. At 4 P.M. of that day, the seat of lowest pressure lay evidently between Deesa and Neemuch, the

heavier air, while its deposited cloud arrests and absorbs a larger portion of the incident solar radiation. It is a matter of daily observation in India, that such an action is accompanied with a fall of temperature at the earth's surface; and thus the reduction in the density of the higher strata does not affect a barometer on the earth's surface to the full extent of the change, locally effected, but only in so far as this is not compensated by the increased density of the lower stratum regarded as of constant vertical thickness.

If, on the other hand, the lower atmosphere be the seat of the action, this may be brought about either by a change of wind, a warmer current replacing one from a cooler quarter, or by the local absorption of heat, either solar radiation or that from the ground heated by the sun. In India, in the month of July, it is mainly with the latter condition that we have to deal. In this case, the higher strata will not, of necessity, be much affected. Any reduction of static pressure is, in this case, at its maximum at the earth's surface, and diminishes more or less rapidly as the elevation increases.

Now, it is obvious, on comparing the above two cases, that a small reduction of pressure shewn by the barometer at the earth's surface, if due to the former kind of action, indicates a far greater disturbance of local equilibrium than if due to the latter; and if, therefore, in an area of tolerably uniform barometric depression, the observed change be partly due to the one, partly to the other action, that portion of the area, in which the higher atmospheric strata are primarily affected, will be the seat of most active indraught and further precipitation.

So far with regard to static changes. But so soon as a rapid current of air pours in from any quarter towards an area of reduced pressure, a redistribution of atmospheric pressure is set afoot by dynamic action. The fall of pressure, originally local, will be communicated to the surrounding region; and especially, in consequence of terrestrial deviation, to that which lies to the left hand of the strongest current; in the case of a west wind, *viz.*, the region immediately to the north.

Now, applying these considerations to the case before us, we find that in Western India the seat of the greatest fall of pressure was partly in Gujarat and Surat, partly in Khandesh, Berar and the Deccan. The former was also the seat of very heavy rainfall, both on the 10th and 11th; and the temperature, as far as appears from the registers of Surat and Rajkot, was low and falling. At Deesa, there was a rise of temperature, which is in accordance with the usual experience, the rain having been very heavy on the 10th, and but slight on the night of that day and during the 11th. But in a portion of the Deccan, as represented by Poona, Buldana, Chanda and Nagpur, there was a general rise of temperature, most considerable at Chanda and Nagpur, both situated in the heart of a rainless region. The data here dealt with are as follow. I include a number of the surrounding stations, in order to shew the better the general character of the temperature changes in the two tracts here contrasted:—

	Temperature at 10 A.M.				Temperature at 10 A.M.		
	10th	11th	Change		10th.	11th.	Change.
Deesa	83·0°	87·6°	+4·6	Malegaon	84·1°	80·3°	−3·2
Neemuch	81·0°	79·8°	−1·2	Buldana	78·6°	79·8°	+1·2
Indore	78·8°	79·1°	+0·6	Poona	75·0°	76·8°	+1·8
Rajkot	89·2°	78·8°	−6·2	Sholapur	83·8°	82·8°	−1·0
Surat	81·6°	79·6°	−2·0	Secunderabad	80·6°	78·6°	−2·0
Bombay	81·9°	77·9°	−4·6	Chanda	70·4°	81·1°	+4·7
Khandwa	83·3°	80·3°	−3·0	Nagpur	70·7°	80·7°	+4·0

It appears then, that as regards the Deccan the fall of pressure between the 10th and 11th may have been partly due to the increase of temperature, indicated by the latter stations of the above list. But as regards Gujarat and Surat with the neighbouring region to the east and south-east, the fall of pressure was accompanied with a very marked fall of temperature; and as it was an area of excessive precipitation, in the absence of any other apparent agency competent to produce this local reduction of pressure, we may attribute it, with some probability, to the active condensation going on in the higher strata of the atmosphere. The result was a great increase in the strength of the westerly monsoon, which fed the rainfall; and this, in accordance with the principle above laid down, determined a fall of pressure immediately to the north, and a transfer of the pre-existing minimum to the more southerly position which it occupied at 10 A.M. of the 11th, and which is shewn on the chart, Plate XI. The increase in the strength of the monsoon current, across Kathiáwar, Surat and Khandesh, and its simultaneous decrease in Cutch, are shewn in the following table, in which the rate of movement in miles per hour, at the hours of observation, 10 h. and 16 h. are given, as computed from the total movements recorded in the intervals. As these are alternately periods of 18 hours and 6 hours, on the assumption that the total distances indicated by the anemometer, when divided by 18 and 6 respectively, give the velocity at the middle of each period, the rate at 10 hours is computed by adding the mean velocity of the preceding 18 hours to three times the mean velocity of the succeeding 6 hours, and taking one-fourth of the sum. In like manner that for 16 hours is obtained by adding three times the mean hourly movement of the preceding 6 hours to that of the following 18 hours, and dividing by 4. This method of computation, although rough, probably gives an approximation sufficient for the present purpose. For Deesa, unfortunately, the anemometric data are wanting. Those for Bombay are taken from the traces of the Beckley's anemograph at the Colaba Observatory, and are actual rates:—

Computed wind velocity miles per hour.

Stations.	10th July				11th July			
	10 h		16 h		10 h.		16 h	
	Dir.	Vel	Dir.	Vel	Dir.	Vel	Dir.	Vel
Kurrachee	SW	21	WSW	23	W	24	WSW	25
Bhuj	WNW	40	SW	50	WNW	23	W	22
Rajkot	WSW	10	SSW	18	W	19	WSW	21
Surat	SW	19	SW	18	SW	35	SSW	37
Malegaon	W	7	WSW	6	W	32	W	32
Bombay	SW	24	WSW	31	W	29	W	30

Up to the evening of the 11th, the barometric depression was but slight. At 4 P.M. of that day, the seat of lowest pressure lay evidently between Deesa and Neemuch, the

owest pressure shewn on the chart, (Plate XI), being, as reduced to sea-level values, 9·357″ at Deesa, and 29·368″ at Neemuch. In the 6 hours that had elapsed since 0 A.M. of the forenoon, the seat of minimum, as far as this can be inferred from the egisters, had been transferred about 100 miles to the south-east, or directly towards the eat of excessive rainfall of this day in Eastern Gujarat, and also towards the rapidly ncreasing monsoon current shewn in the above table at Surat and Malegaon. The fall f pressure, in these 6 hours, at the stations in this part of Western India, was, as hewn in the first column of the following table. The second column gives the normal iurnal fall for the month of July, and the third the residual fall which may, therefore, e regarded as abnormal, and as an effect of the local condensation :—

Barometric change from 10 hours to 16 hours of the 11th July.

	From obs	Normal	Abnormal.
Pachbudra	— 0·101 inch.	— ·097	— ·004
Deesa	— 0 138 „	— 108	— 030
Bhuj	— 0 112 „	— ·073	— 039
Rajkot	— 0·069 „	— 079	+ ·010
Surat	— 0 104 „	— 081	— ·023
Malegaon	— 0·083 „	— 081	— 002
Bombay	— 0 089 „	— ·067	— 022
Khandwa	— 0 093 „	— ·088	— 005
Indore	— 0 124 „	— 089	— 035
Neemuch	— 0 116 „	— 079	— 036

Up to the afternoon of the 11th, there was no concentration of the storm; there was n extensive barometric depression and a slight circulation of air around; but no distinct torm vortex. This latter appears to have formed, rapidly, between Rajkot and Bhuj, n the night of the 11th—12th July*, and by 10 A.M. of the 12th, was well established i the position, which it retained, with but slight change, until it broke up on the fternoon of the 13th; as is shewn by the charts for 10 h. and 16 h. of the 12th and 3th July (Plates XII and XIII). The registers of temperature, pressure, and wind, apour tension, humidity and cloud for these several hours, and the abnormal changes f pressure (after deducting the normal oscillations), for each interval after 16 h. (4 P.M.) f the 11th, are given in the following table, for the same stations as were enumerated in the table for the 11th on page 86 The velocity of the wind at the hour of bservation has been computed in the manner already described.

* See the report of Colonel Burton, Political Agent, Kathiáwar, *postea*, p 97

Weather Table of the 12th July

Stations.	10 A.M. Reduced Barometer. Reading	10 A.M. Reduced Barometer. Abnormal change	10 A.M. Temperature	10 A.M. Wind. Direction	10 A.M. Wind. Miles, hourly	10 A.M. Vapour tension	10 A.M. Relative humidity	10 A.M. Cloud proportion	4 P.M. Reduced Barometer. Reading	4 P.M. Reduced Barometer. Abnormal change	4 P.M. Temperature	4 P.M. Wind. Direction	4 P.M. Wind. Miles, hourly	4 P.M. Vapour tension	4 P.M. Relative humidity	4 P.M. Cloud proportion	Rainfall, 24 hours
Jacobabad	29 580	—·018	94·9	SW	4	·838	51	8	29 381	—·010	98·6	SSE	3	·625	45	9	
Mooltan	536	—·060	94·0	Calm	1	832	52	6	·387	—·049	93·0	Calm	2	665	43	7	
Sirsa	·509	—·038	92·9	E	12	921	59	3	379	—·026	97·7	SE	14	846	47	1	
Agra	·477	—·051	88·2	E	13	·971	73	10	317	—·013	80·2	E	13	·056	77	8	0·67
Jeypore	491	—·024	84·9	ESE	F	·941	87	8	414	+·001	80·9	SSE	F	·911	95	10	0·43
Ajmere	473	—·025	82·3	NE	6	808	81	9	407	+ 003	82·3	SE	5	·850	77	9	2·16
Bickaneer	·474	—·054	88·2	ENE	8	·752	56	5	306	—·031	92·1	SE	8	·881	58	10	...
Pachbudra	·442	—·049	90·0	E	11	933	66	5	·316	—·024	94·5	S	11	829	51	8	
Deesa	·464	—·019	77·9	SSE	F	·913	95	10	311	+ 001	83·2	S	F	867	77	8	0·25
Neemuch	492	—·005	79·1	SSW	8	·826	83	10	362	—·014	83·7	WNW	10	827	62	9	..
Indore	·533	+ 004	76·1	S	8	835	93	10	·461	+·033	76·0	SW	8	816	91	10	0·33
Khandwa	565	—·011	77·3	SW	9	854	91	9	·493	+ 016	77·3	SW	8	·856	91	9	0·11
Malegaon	607	—·002	81·9	WSW	18	741	68	10	507	—·001	84·7	W	17	·707	59	10	0·02
Surat	525	—·018	80·8	SSW	30	·946	90	10	·448	+ 011	83·4	SW	31	·948	83	10	2·50
Rajkot	413	—·188	74·2	W	44	814	96	10	229	—·090	75·1	W	49	·855	98	10	5·93
Bhuj	·346	—·166	79·1	N	27	954	96	10	153	—·105	81·1	NNW	28	·974	91	10	4·03
Hyderabad	538	+ 025	86·3	NNE	16	·764	61	10	·441	—·001	81·2	N	18	·959	90	5	0·19
Kurrachee	492	—·057	90·5	W	16	917	93	6	·406	—·012	85·3	WSW	15	1·020	82	9	0·02
Bombay	653	—·026	80·3	WSW	34	·934	90	10	572	—·004	81·0	WSW	28	935	80	10	1·02

only observations available have been those recorded on ships, with unverified instruments, and in positions which, in many cases, could be determined only approximately and with more or less probability of error. Added to which, all measurement of that most important element, the rainfall, around the birthplace of the storm, has been impracticable. It is therefore an occurrence of more than ordinary interest that presents itself in the Gujarat storm of the 11th and 13th July 1881; which, having been generated on a land surface, in the midst of well equipped meteorological observatories, has fulfilled, in a high degree, all those conditions that are demanded by scientific enquiry.

The successive steps in the formation of this storm, as they have been traced in the above discussion, are as follow:—

First.—There existed, on the 10th July, a very extensive area of low barometer, running across Northern India, and including two minima; the larger of which, of very slight intensity, occupied nearly the whole of Rajputana and much of the adjacent territory west of the Aravalis. Within and around this, the winds were very light, and very variable in direction, except on the south, where a strong south-westerly monsoon current blew across Cutch.

Second.—In the next 24 hours, the depression was slightly intensified, in consequence of a general slight barometric fall, over a well-defined area in Northern India and the northern half of the peninsula, and a slight rise around its borders. As regards the Punjab and Indus valley, the rise of pressure is an instance of a phenomenon very common in this region, at all seasons of the year, after rain; and, in this case, it followed on the cessation of unusually heavy rain But rain continued over the northern half of the area of falling barometer (excepting in Sind and Western Rajputana), and was especially heavy in the east and south of Gujarat, *viz.*, along the Aravalis and in Kathiáwar; to the north-west of which region, a slight cyclonic circulation was set up, around the seat of minimum pressure. The strong monsoon current, which fed this rainfall, at the same time shifted to the south, the wind falling at Bhuj (in Cutch) and increasing at Rajkot, Surat, and Malegaon.

Third.—The heaviest rain of all was in the north-west of Kathiáwar, where the stormy west wind swept the opposed slopes of the low hill range that traverses that peninsula; but although the wind was high, there was no appearance of a cyclonic vortex in this region, until the night of the 11th. Whether the slight depression, with a cyclonic circulation around, which existed between Deesa and Neemuch, at 4 P.M. of that day, was rapidly intensified and transferred to between Bhuj and Rajkot (a distance of 200 miles), or whether a new vortex was formed by the eddying wind in the new position, the previous depression becoming evanescent, is a point on which evidence is wanting. But it is certain that the storm vortex which first appeared between Bhuj and Rajkot on the night of the 11th, coincided exactly in position with the seat of the heaviest rainfall, much of which had fallen during the previous day; and that, during the whole of the 12th and the forenoon of the 13th, it shifted but slightly to the westward of its place of origin, a deluge of rain falling without intermission immediately around.

APPENDIX A.

Report of COLONEL L. C. BURTON, *Political Agent, Kathiáwar, dated 18th July 1881.*

I regret to have to report, for the information of Government, that very great damage has been occasioned by the heavy storm that swept over this province last week.

The centre of the cyclone appears to have travelled in a north-easterly direction through the Halar, striking the land about midway between Porebunder and Dwarka, and passing over Nawanagar, Dhrol and Morvi,* and doing great damage in these towns and the surrounding country.

Reports from Nawanagar state that rain commenced falling on the 11th; the river Naginati, which runs by the town, was in flood early on that day, and penetrated into the houses, carrying away much property and cattle. On the night of the 11th, the wind increased to a gale and was accompanied by torrents of rain; the town was inundated; about 1,000 houses, it is computed, collapsed, and there was some loss of life. The storm continued, without cessation, until the afternoon of the 13th, 28 inches and 90 cents of rain being gauged.

The town of Dhrol has suffered even more severely, three-fourths of the houses are said to be in ruins; 33½ inches are reported to have fallen here during the storm.

Morvi was struck by the storm about 10 o'clock on the night of the 11th, after which it rained and blew, without intermission, for 30 hours. After a short lull, another fall took place, lasting 16 hours; and again on the 14th, the storm lasted from 10 A.M. until sunset. During its continuance, 25·54 of rain fell. The damage done has been very great, the extensive suburb of the town has been nearly destroyed, and all the valuable property, stored in warehouses there, washed away. Many houses in the town have fallen down, the jail was flooded and had to be vacated, and it is feared there has been considerable loss of life, as well as property, not only in Morvi itself, but throughout the district. Whole villages are reported to have been swept away; while the minor towns are stated to have suffered in a greater degree than the capitals.

The chiefs, with their usual liberality, are providing food and shelter for the homeless. The Thakore Saheb of Morvi distinguished himself by his activity. He went about the town during the storm, providing food and shelter for those in need of it, thereby giving an excellent example, and infusing energy into his subordinate officers.

In Rajkot, the storm was very severe during the 11th and 12th, but subsided on the 13th. The return of rainfall is as follows:—11th, 6 inches 16 cents; 12th, 6 inches 26 cents; 13th, 2 inches 80 cents; total 14 inches 72 cents. Considerable damage was done to buildings and trees, but it is evident that we escaped the full force of the storm, which appears to have had its axis in a line running from south-west to north-east, passing about 50 miles to the north of this station. In Jodiya, for instance, it is reported that 50 inches of rain fell during the storm.

A further report will be submitted when full particulars regarding the extent of the damages and loss of life have been received.

Report of H. N. REEVES, ESQ., *Political Agent, Cutch, dated 26th July 1881.*

With reference to the recent cyclone, the centre of which is said to have passed somewhere near Bhuj, I have the honour to submit certain information collected from some of the principal towns in Cutch, regarding the effects of the gale of wind and heavy rain, which occurred between 11th and 14th July.

From 6 P.M. on the 10th to 6 P.M. of 14th, 8 inches and 2 cents of rain fell at Bhuj. The readings of the barometer and thermometer, humidity of the air, the velocity and direction of the wind on the dates above mentioned, are given in Appendix A.† In the city and immediate neighbourhood, six houses fell down, 185 were partially injured, and 350 trees were blown down.

* This inferential course of the storm is, of course, erroneous, as applying to the vortex. It almost describes the course of the most violent wind blowing up to the storm centre.

† Omitted here, the data for Bhuj having already been given in the Tables in the text.

The rainfall at Mandvi from the night of the 11th up to midday of the 14th is given below:—

12th July, Tuesday	.	14 inches 80 cents.
13th „ Wednesday	.	5 „ 74 „
14th „ Thursday	.	1 „ 00 „
	Total .	20 inches 54 cents.

The readings of the barometer and thermometer on those three days, as well as the direction of the wind, were as follow:—

	Barometer readings.		Thermometer readings.	
	10 A.M.	6 P.M.	10 A.M.	6 P.M.
12th,	29·22	29·13	85	84
13th,	29·30	29·27	84	83
14th,	29·40	29·39	82	83

Direction of the Wind.

12th July	NW.
13th „	SW.
14th „	NW.

I regret to say that the barometer has been discovered to be out of order, so that the above observations are not quite correct; but the amount of rain, registered on the first two days, was quite abnormal. The water brought down from the Charwa range by the Bookee river, which flows past the town of Mandvi, cut away the sand bar between the point of the wharf wall and the groyne, and lowered it 3 feet. The channel of the river was widened, 2 feet at its mouth and 5 feet off the wharf wall, a part of which was injured, and one of the four end blocks which form a sort of pier head to the breakwater, sank several feet; 120 houses wholly or partially fell down; the number of the trees blown down has not been ascertained, but it is very great. Four large and five small Pattymars, value about Rs. 12,000, were carried out to sea. Timber stacked on the banks of the river, worth about Rs. 17,000, was washed away. A man who was in one of the boats when it floated out of the harbour, has not since been heard of.

There is no barometer at Anjar; the readings of the thermometer, the rainfall, and the direction of the wind, however, were recorded as follow:—

Thermometer readings.

	9 A.M.	6 P.M.
12th July	82	82
13th „	80	82
15th „	78	82

Rainfall.

12th July	6 inches.	50 cents.
13th „	1 inch	60 „
14th „	2 inches	64 „
Total	10 „	70 „

Direction of the Wind.

12th July	N.
13th „	N. S. W.
15th „	W.

In this district, 305 houses and 150 trees were more or less injured. Four head of cattle were swept away by floods. At *Khari Rohur* four boats drifted out to sea, and have not since been found. At Toona, 3 or 4 boats were injured by being violently dashed against one another. Some timber lying on the shore at this port has also disappeared. The bund, built by Shingjibhai of Mandvi, across the Toona river, last year, at a cost of Rs. 800, has been destroyed.

At Bachao the rain, registered in the town itself, during the three days and the night of the 11th, is as follows :—

Night of Monday, 11th July	7 inches	90 cents.
Tuesday, 12th July . . .	...	16 „
Wednesday, 13th July . . .	1 inch	46 „
Thursday, 14th „ . . .	2 inches	89 „
Total ,	12 inches	41 cents.

About 400 houses and 300 trees suffered damage in this taluka.

From the above facts and observations, it would appear that the centre of the cyclone did not reach Bhuj, the storm was more violent, and the rain fell more heavily at Mandvi than at Bhuj, and the State Engineer tells me that, so far as he can gather, it passed through the Gulf of Cutch or over the opposite coast of Kathiáwar.

APPENDIX B.

Statement giving the daily rainfall at stations in the districts enumerated in Gujarat and Sind.

Stations.	June 1881.					Stations.	June 1881.				
	10th.	11th.	12th	13th.	14th.		10th.	11th	12th.	13th	14th.
Kathiáwar.						*Kathiáwar*—contd.					
Wadhwan . . .	0·22	2 22	1·72	0·10	0·33	Mahuwa . . .	2·30	1·59	0·52	0 92	0·10
Chotila . . .	0·80	0 45	1·45	0·60	0 25	Kundla . . .	0 34	0·45	0·34	1·00	...
Dasada . . .	0·40	...	2·85	0·13	0 00	Lilia . . .	0·88	0·72	0·17	0·01	...
Bhoika . . .	0·20	2 26	0·09	0 34	0 32	Oomrala . . .	5·61	2·32	0 50	...	...
Pallad . . .	0·28	0 40	...	1·25	...	Botad . . .	0 61	2·07	0·54	0·35	0·20
Jhinjuwada . .	0·50	0·25	2·60	...	1 23	Gadhda . . .	2·40	0·63	0 20	0·11	0·12
Vithalghad . .	0·15	3·37	...	0·35	0·43	Talaja . . .	6·38	3·60	0·11	0 38	0·27
Manekwara . .	1·24	0·96	1·06	1·98	0·28	Velavadar . .	1·60	1·80	...	1·30	...
Lakhapadur . .	0·13	1·28	...	1 20	0 23	Palitana . . .	1 32	3 27	0·17	0·56	...
Bagasra . . .	1·01	0 68	0·38	1·55	0·34	Gerindhar . .	1·60	1·25	0·05	0·20	1·00
Rafala . . .	0·54	5 68	3 70	4·20	0·48	Timba . . .	1·18	1·47	...	0·75	...
Jetpur . . .	1·98	0·65	0 53	...	...	Valukad . . .	1·23	1·40	0·15	1·10	0·05
Bilkha . . .	2 52	7·18	1·47	1·16	4 62	Thaduch . . .	2 00	2·50	...	0·30	.
Chital . . .	0·18	1·06	2·23	3·78	1·04	Vala	3·64	1·91	0·07	0 44	0·07
Mendarwada . .	5·16	1 02	0·98	0·46	...	Jasdan . . .	1 54	0 90	0·75	1·65	1·83
Gondal . . .	4·03	2·72	3 93	2·17	1·61	Vichhia . . .	1·62	0·50	0 34	0·47	1·00
Dhoraji . . .	0·75	2 87	4·20	3·50	1·12	Lathi . . .	0·95	0·90	0 25	0·08	...
Upleta . . .	2·80	4 95	4·65	4·45	0·93	Babra . . .	2 90	1·61	0·22	0 99	0·15
Sarsai . . .	1·33	1·05	1·22	1 48	0·34	Songadh . . .	2·97	2·91	0·21	0 62	0·04
Bhayavadar . .	2·40	4 92	4·38	3 97	0·53	Datha . . .	1·80	1·79	0·10	0 70	0 54
Bhavnagar . .	3 03	3·61	0·05	0·63	0·03	Chamardi . . .	4·49	1·10	..	0 30	...
Sihor . . .	3 56	2·02	0·14	0·70	0·09	Chok . . .	3·60	2 00	..	...	0·2

IV.—On the Temperature of North-Western India:—By S. A. Hill, B.Sc., *Meteorological Reporter to Government, North-Western Provinces and Oudh.*

Nearly eight years having now elapsed since the establishment of the Indian Meteorological Department, while, in all the more important provinces, local arrangements for the collection and publication of trustworthy meteorological observations were made eight or ten years previously, the time has now arrived when it may fairly be assumed that normal values of the temperature and other climatological elements, for most parts of the country, are attainable. But if one may judge from the maps given in modern text-books of physical geography and meteorology, the prevailing notions regarding the distribution of temperature and barometric pressure in India are still very inaccurate. This paper has therefore been compiled with the object of correcting these ideas as regards temperature; but since the labour of working out the normal temperatures for the whole of India and Burma would be very great, and since I have no personal knowledge of Southern and Eastern India, I have confined the scope of the present paper to the North-West; including, under this term, all those portions of the Indian area, which lie north of the 20th parallel and west of the meridian of 86°E. from Greenwich.

The discussion of the temperature of the rest of the country is better left to other officers of the Meteorological Department, and moreover, it will be most satisfactorily performed after the reduction of the observations collected from the Indian Seas, now, I believe, in progress.

In this paper, we have to deal with a land area equal to that of Central Europe,—that is, to the whole of Europe with the exception of Russia and the Scandinavian, Balkan, and Iberian peninsulas—in which, up to the present time, temperature observations of the following classes have been made:—*

I. Observations of a standard or verified thermometer, under a thatched shed, for several years, at 4, 10, 16, and 22 hours, local time; or at 10 and 16 hours only, together with hourly observations on four complete days in each month, and daily observations of the self-recorded maxima and minima.

II. Observations of the state of the thermometer at 10 and 16 hours and of the maxima and minima only; the instruments, however, being exposed under thatched sheds, and being for the most part verified and corrected.

III. Observations of a somewhat desultory and uncertain kind, made at hospitals and dispensaries or by private observers, the thermometer being unverified and the exposure various; the hours of observation also various, but most frequently sunrise and 4 P M.

In the map which gives the normal distribution of the mean annual temperature [Plate XIV], the stations, at which the three classes of observations have been taken, are distinguished by different signs. Those of the first and second class are furnished by the Government observatories and a few others equipped on the same scale. From the numerous observations of the third class, a selection has been made; none being taken, unless they agreed fairly with the nearest of Class I or II, or unless they belonged to some region not otherwise represented.

Observations of the third class, made in earlier years have, however, in many instances been used to extend the register of the present meteorological observatories, the annual

* At the Maharaja's Observatory, Jaipur, the temperature is now automatically recorded by one of Van Ryssselberghe's Meteorographs, but none of the traces have yet been tabulated.

means of the two series, in such cases, differing by less than the probable error of the mean.

Diurnal Variation.

The first step towards the establishment of the normal temperature of a place, is the determination of the daily variation, and the correction which must be applied to the mean founded on any given combination of hours, in order to reduce it to the true diurnal mean. For the purpose of determining such corrections, the hourly observations, mentioned above, were instituted in 1875 and 1876, and are still being carried on. On each term day, (the 7th, 14th, 21st and 28th of the month), twenty-five observations of temperature, extending from midnight to midnight, are made.

All the hourly observations, for any given month, having been tabulated and the means struck, and any residual difference between the two midnight means having been distributed equally, the observations at 4, 10, 16 and 22 hours (when such had been taken) were inserted and the figures altered accordingly, as described in Volume I, page 63. The figures for the day hours were then in some cases further corrected by means of a longer series of observations at 10 and 16 hours. In this way were obtained the corrected hourly means and the true diurnal mean for each month.

Table I gives the variations from the diurnal mean, at 4, 10, 16 and 22 hours, for every station at which hourly observations have been recorded; also the daily extremes, as given by self-registering thermometers; and the periodic maxima and minima, with the hours at which they occur. The periodic extremes have been obtained, by parabolic interpolation, from the observations of the three hours nearest to the maximum or minimum; the epoch of the minimum, at least, being determined more exactly by this method than by means of Bessel's formula. The data in the table will suffice for the graphic reconstruction of the diurnal curves, and they occupy much less space in printing than the full series of hourly values would have done.

For several stations, at which no hourly observations were made, approximate values of the hourly means have been obtained, by inserting the observations made at 4, 10, 16 and 22 hours at these stations, in the hourly series for some station or stations not very distant, and correcting the other figures accordingly. The data on which the diurnal curves for each place are founded, are mentioned in the heading of each table.

No regular series of hourly readings having been made at any of the Himalayan stations of 6,000 or 7,000 feet elevation,* I have attempted to construct hourly curves for Chakráta and Ránikhet, by parabolic interpolation between the 4 A.M., minimum and 10 A.M. observations, the 10 A.M. maximum and 4 P.M. observations, and the 4 P.M. 10 P.M. and 4 A.M. observations. The extreme values being those given by self-registering thermometers, the range of the curves is too great; but the epochs of minimum and maximum are probably not far wrong; and the calculated hourly values suffice to show that, the mean of the four equidistant observations, at 4, 10, 16 and 22 hours, does not differ, in any month, by more than 0·2° from the mean of the day—a conclusion which is confirmed by occasional series of observations made by travellers, for example, by Dr. Scully's Series at Murree and Srinagar, given in Volume I, page 224 of this serial; and which might indeed be inferred from the small diurnal range at these elevations. For hill stations between 5,000 and 8,000 feet, we may therefore assume the mean of four equidistant observations to be the true mean of the day.

* Except those by Colonel Boileau, at Simla, in the years 1843 to 1845, and, in this case, the conditions of exposure were such, as to render them not comparable with the temperature readings now recorded at the Government Observatories.

TABLE I.—*Diurnal variation of Temperature.*

STATION: LEH.

Latitude, 34° 10′ N.; Longitude, 77° 42′ E.; Elevation, 11,538 feet.
Data— Hourly observations . . . . 12 days each month.
Maxima and Minima 4—5 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Δ Periodic Maximum.	Self-registered Minimum.	Mean daily Range
	°	°	°	°	°	°	H. M.	H. M	°	°	°
January . .	− 8·9	+6·7	+ 7·9	−3·7	+11·6	− 9·6	13 38	5 15	+13·4	−10·1	23·5
February . .	− 8·7	+7·1	+ 7·2	−3·6	+10·6	−10·1	13 37	5 31	+11·6	−12·0	23·6
March . .	− 8·0	+3·9	+ 8·7	−3·2	+10·5	− 8·8	13 30	4 57	+11·0	−10·9	21·9
April . .	− 9·2	+5·2	+ 7·9	−3·6	+10·2	−10·3	13 30	4 43	+12·8	−12·9	25·7
May . .	−11·0	+5·1	+ 9·9	−4·5	+12·5	−11·8	14 34	4 37	+14·1	−12·6	26·7
June . .	−11·3	+3·6	+12·3	−4·9	+12·3	−12·1	15 26	4 38	+14·5	−12·7	27·2
July . .	−10·1	+1·4	+12·3	−3·8	+13·3	−11·1	14 20	4 44	+15·7	−11·7	27·4
August . .	−10·2	+3·8	+10·7	−3·8	+12·1	−10·7	14 14	4 38	+13·7	−11·7	25·4
September . .	−10·2	+5·3	+10·1	−4·6	+12·9	−11·1	13 42	4 41	+14·0	−13·1	27·1
October . .	− 9·4	+4·5	+ 8·8	−3·4	+12·0	−10·2	13 21	4 55	+13·1	−13·0	26·1
November . .	− 8·7	+5·3	+ 8·7	−3·5	+11·7	− 9·8	13 15	5 17	+12·7	−12·1	24·8
December . .	− 8·9	+6·5	+ 8·7	−2·9	+11·2	− 9·9	13 56	5 30	+12·0	−10·7	22·7
Year . .	− 9·6	+4·8	+ 9·4	−3·8	+11·7	−10·5	13 55	4 57	+13·2	−12·0	25·2

* The thermometer in use having given erroneous readings, these figures have been taken from the hourly observations. They represent the mean excess of the highest hourly reading above the mean of the day.

STATION: CHAKRÁTA.

Latitude, 30° 40′ N.; Longitude, 77° 55′ E.; Elevation, 7,052 feet
Data— Six hourly observations . . . . 5—6 years.
10 hours and 16 hours observations. . 6 additional years.
Maxima and Minima . . . . 11—12 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Time of Maximum.	Time of Minimum	Self-registered Maximum.	Self registered Minimum	Mean daily Range.
	°	°	°	°	H. M.	H. M.	°	°	°
January . .	−4·4	+3·9	+2·8	−2·5	12 58	5 22	+ 9·9	−5·4	15·3
February . .	−4·4	+3·2	+3·6	−2·4	13 3	5 34	+ 9·6	−5·5	15·1
March . .	−5·3	+3·8	+4·0	−2·8	13 4	5 47	+ 9·8	−7·3	17·1
April . .	−6·7	+4·9	+5·4	−3·6	13 4	5 21	+10·1	−7·8	17·9
May . .	−6·3	+5·0	+5·3	−3·8	13 3	5 16	+ 9·3	−8·1	17·4
June . .	−5·4	+3·9	+4·1	−2·6	13 0	5 40	+ 8·0	−7·1	15·1
July . .	−3·3	+2·4	+2·2	−1·3	12 58	5 44	+ 5·9	−4·5	10·4
August . .	−2·9	+2·5	+1·8	−1·5	12 51	5 42	+ 5·5	−3·9	9·4
September . .	−3·4	+3·0	+2·5	−2·0	12 54	5 30	+ 6·8	−4·2	11·0
October . .	−5·2	+4·8	+3·7	−3·3	12 49	5 13	+ 8·7	−5·9	14·6
November . .	−5·3	+5·4	+3·3	−3·6	12 41	5 8	+ 9·4	−5·9	15·3
December . .	−4·4	+4·5	+2·3	−2·4	12 45	5 42	+10·1	−5·6	15·7
Year . .	−4·7	+3·9	+3·4	−2·7	12 55	5 30	+ 8·6	−6·0	14·5

TABLE I.—*Diurnal Variation of Temperature*—contd.

STATION RÁNIKHET.

Latitude, 29° 33 N, Longitude, 79° 29' E, Elevation 6 069 feet

Data—
Six hourly observations . . . . 4—5 years
10 hours and 16 hours . . . . 6 additional years
Maxima and Minima . . . . 10—11 years

Month.	4 hours.	10 hours	16 hours	22 hours	Time of Maximum.	Time of Minimum	Self registered Maximum	Self registered Minimum	Mean daily Range
	°	°	°	°	H. M	H M	°	°	°
ary .	—5 0	+2 4	+4 8	—2 3	13 21	5 40	+8 0	—5 3	15·2
uary	—4 9	+1 8	+5 1	—2 2	13 32	6 0	+8 2	—7 1	15 3
h .	—5 3	+2 8	+5 5	—2 9	13 25	6 1	+9 2	—8 1	17 3
l	—5 3	+3 3	+5 3	—3 3	13 24	6 7	+8 4	—9 0	17 4
. .	—5 4	+3 6	+4 9	—2 9	13 13	6 0	+8 7	—8·4	17 1
. .	—5 3	+2 3	+4·6	—1 6	13 22	5 39	+7 2	—6 6	13 8
	—3 9	+1 6	+3 2	—1 1	13 20	5 35	+6 0	—4·7	10 7
ist	—3 2	+1 5	+3 1	—1 4	13 23	5 42	+5 5	—3 8	9 3
mber	—4 1	+2 5	+4 1	—2 5	13 19	5 36	+7 2	—5 1	12 3
ber	—5 3	+3 1	+5 7	—3 5	13 28	5 31	+8 5	—6 4	14 9
mber	—5 7	+3 2	+5 2	—2 8	13 19	5 46	+8 9	—7 4	16 3
nber .	—5 1	+2 4	+4 3	—2 4	13 17	5 53	+8 8	—7 1	15 6
Year .	—4 9	+2 5	+4 7	—2 4	13 22	5 47	+8 0	—6 6	14 6

STATION LAHORE

Latitude 31° 34 N, Longitude, 74° 20' E, Elevation 732 feet

Data—
Hourly observations . . . . 20 days each month
Six hourly ,, ... 5 years
Maxima and Minima . . . . 5 ,,

Month	4 hours	10 hours.	16 hours	22 hours	Periodic Maximum	Periodic Minimum	Time of Maximum	Time of Minimum	Self registered Maximum	Self registered Minimum	Mean daily Range.
	°	°	°	°	°	°	H M.	H. M	°	°	°
ary	— 9 2	+3 3	+13 1	—3 8	+13 6	—10·0	14 58	6 30	+15·4	—12 0	27 4
uary .	— 8 6	+3 0	+11 3	—3 4	+11 9	— 9 3	14 57	5 50	+13 3	—11 2	24 5
h	—10 1	+4 0	+12 1	—3 8	+12 7	—12 0	14 40	5 49	+14 2	—12 7	26 9
l	—12 2	+5 5	+12 7	—5 4	+13 1	—12 5	14 20	5 50	+15 5	—14 8	30·3
	—12 0	+5·2	+12 1	—5 0	+12·7	—12 2	14 28	4 34	+14 9	—14 1	29·0
	—10·6	+4 3	+11 4	—4 4	+12 6	—11 1	14 5	4 49	+14 8	—12 4	27 2
. .	— 7 0	+2·0	+ 7 4	—2 6	+ 8·2	— 7 3	14 15	4 55	+11 0	— 8 5	19 5
ust	— 6 3	+2 6	+ 6 5	—2 5	+ 7 1	— 6 7	14 42	5 0	+10·1	— 7 8	17 9
ember .	— 7 8	+3 9	+ 9 0	—3 6	+ 9 4	— 8 9	14 30	5 39	+10·9	— 9 6	20 5
ber	—10 6	+5 8	+13 1	—5 3	+13 9	—11·3	14 55	5 42	+15 4	—12 8	28·2
ember	— 9 5	+6 5	+14 1	—6·1	+15 6	—11 2	14 30	6 4	+17 4	—13·0	30 4
mber	— 9·0	+4 3	+13·0	—4 9	+14 4	—10 4	14 44	6 37	+16 0	—11 9	27 9
Year	— 9 4	+4·2	+11 3	—4 2	+12 1	—10 2	14 36	5 37	+14 1	—11·7	25 8

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: KURRACHEE.

Latitude, 24° 47′ N.; Longitude, 67° 4′ E.; Elevation 49 feet.

Data—Hourly observations, 15-16 days each month. Maxima and Minima, 18 years. } From the *Meteorology of the Bombay Presidency* by C. CHAMBERS, F.R.S.

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.*	Self-registered Minimum.*	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January	− 7·9	+3·6	+ 9·9	−2·3	+10·4	− 9·7	14 25	6 10	+13·0	−11·2	24·3
February	− 8·7	+4·5	+ 9·8	−3·2	+10·5	−10·3	14 15	5 58	+13·7	−10·8	24·5
March	− 6·7	+4·8	+ 9·5	−1·8	+ 7·9	− 8·7	12 30	5 52	+12·2	−10·1	22·3
April	− 6·4	+4·9	+ 5·4	−3·0	+ 3·1	− 7·0	12 56	4 51	+11·7	− 7·5	19·2
May	− 4·9	+3·4	+ 4·5	−2·5	+ 5·0	− 5·1	13 45	4 35	+10·9	− 5·1	16·0
June	− 3·7	+3·5	+ 3·3	−2·0	+ 4·6	− 4·1	13 30	4 52	+ 9·0	− 4·4	13·4
July	− 2·3	+2·1	+ 2·3	−1·5	+ 4·1	− 2·0	12 48	4 56	+ 7·0	− 4·2	11·2
August	− 2·7	+2·0	+ 3·1	−1·4	+ 4·3	− 3·0	13 30	5 43	+ 7·3	− 3·1	10·4
September	− 3·6	+3·1	+ 3·6	−1·8	+ 5·1	− 4·1	13 30	5 23	+ 8·1	− 4·9	13·0
October	− 9·5	+4·9	+10·0	−3·1	+11·7	−10·4	13 55	5 36	+13·7	− 7·8	21·6
November	−10·7	+6·8	+11·0	−3·1	+12·5	−12·2	14 0	5 40	+16·4	−11·0	27·4
December	− 7·9	+4·3	+ 9·8	−2·2	+10·6	−10·7	14 18	6 19	+14·2	−12·0	26·2
Year	− 6·3	+4·0	+ 6·6	−2·3	+ 8·0	− 7·3	13 37	5 29	+11·4	− 7·7	19·1

* Thermometers uncorrected, minimum doubtful.

STATION: DEESA.

Latitude, 24° 16′ N.; Longitude, 72° 14′ E.; Elevation, 466 feet.

Data—Hourly observations, 13-17 days each month. Maxima and Minima, 18 years. } From the *Meteorology of the Bombay Presidency* by C. CHAMBERS, F.R.S.

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.*	Self-registered Minimum.*	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January	−11·5	+4·6	+13·3	−3·3	+14·5	−13·1	14 39	6 12	+15·1	−15·7	30·8
February	−12·6	+4·2	+14·1	−2·2	+14·6	−16·0	14 57	6 18	+14·6	−16·6	31·2
March	−12·9	+4·6	+13·1	−2·4	+14·0	−14·5	14 50	5 38	+15·6	−15·5	31·1
April	−11·9	+2·5	+12·1	−0·9	+12·7	−15·2	15 0	5 52	+13·6	−17·1	30·7
May	− 9·9	0·0	+11·5	−0·6	+11·7	−11·7	15 18	5 41	+12·9	−14·1	27·0
June	− 6·3	+0·3	+ 7·8	−1·7	+ 8·0	− 7·0	15 18	4 49	+11·1	− 9·7	20·8
July	− 3·5	+0·7	+ 4·4	−0·6	+ 4·6	− 4·1	15 9	5 46	+ 7·4	− 6·9	14·3
August	− 3·5	+0·6	+ 4·2	−0·8	+ 4·3	− 4·0	15 0	5 39	+ 6·3	− 5·5	11·8
September	− 6·4	+2·0	+ 7·4	−1·5	+ 7·9	− 7·2	15 0	5 36	+ 9·3	− 7·1	16·4
October	−12·9	+6·8	+12·7	−4·4	+13·0	−14·1	14 0	5 50	+14·9	−13·2	28·1
November	−13·1	+7·0	+12·9	−4·0	+14·8	−13·7	14 0	5 3	+16·2	−16·9	33·1
December	−10·4	+6·0	+12·9	−3·7	+14·4	−12·8	14 3	6 6	+15·2	−17·0	32·2
Year	− 9·6	+3·4	+10·5	−2·2	+11·3	−11·1	14 46	5 43	+12·7	−12·9	25·6

* Thermometers uncorrected, minimum doubtful.

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: AJMERE.

Latitude, 26° 26′ N.; Longitude, 74° 37′ E.; Elevation 1,611 feet.

Data—
Hourly observations . . . . . 24 days each month (at Agra).
Six hourly " . . . . . 8—9 years.
10 hours and 16 hours observations . . . . 6 years (in addition).
Maxima and Minima . . . . . 7—14 years.

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
y . .	—12·7	+ 7·4	+15·6	—5·6	+15·8	—13·9	14 42	5 9	+15·9	—14·5	32·4
ry . .	—11·8	+ 6·0	+13·3	—4·7	+14·4	—13·2	14 30	5 16	+15·9	—15·2	31·2
. .	—12·5	+ 7·4	+13·3	—5·2	+14·2	—13·8	14 30	5 9	+16·8	—16·0	32·8
. .	—12·1	+ 7·3	+12·6	—4·9	+13·5	—13·0	14 21	5 4	+15·2	—16·2	31·4
. .	—11·3	+ 5·1	+12·1	—3·8	+12·4	—10·6	14 37	5 0	+15·0	—13·6	28·6
. .	— 8·5	+ 2·8	+10·0	—3·4	+10·1	— 9·0	14 42	5 0	+12·8	— 9·8	22·6
. .	— 5·0	+ 1·8	+ 7·1	—2·2	+ 7·4	— 6·2	14 40	4 48	+10·0	— 6·6	16·6
. .	— 6·1	+ 1·9	+ 6·9	—2·6	+ 7·8	— 6·4	14 37	4 30	+ 8·3	— 6·6	14·9
ber .	— 7·7	+ 3·6	+ 8·5	—4·3	+10·1	— 7·9	14 23	4 38	+10·9	— 8·9	19·8
r . .	—13·0	+ 9·6	+14·1	—7·6	+15·4	—13·1	14 4	4 26	+16·1	—14·0	30·4
ber .	—14·9	+10·9	+15·9	—7·2	+17·5	—15·2	13 54	4 35	+19·2	—16·6	34·8
ber .	—13·1	+ 7·8	+14·3	—5·5	+15·7	—13·6	14 19	4 47	+18·3	—15·1	33·4
Year .	—10·7	+ 6·0	+11·9	—4·8	+12·9	—11·3	14 27	4 52	+14·6	—12·7	27·4

he annually early hour of the daily minimum at this station may perhaps be attributed to the peculiar position of the observatory, which was situated at the foot of a rocky ridge, near an opening in the ridge through which the air, cooled by nocturnal radiation, drained away. In the situation of the observatory near the centre of the plateau, the minimum probably occurs later.

STATION: JEYPUR.

Latitude, 26° 54′ N.; Longitude 75° 49′ E.; Elevation 1,430 feet.

Data—
Hourly observations . . . . . 4 days each month.
Six hourly " . . . . . 1 year.
Maxima and Minima . . . . . 1 "

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
ry . .	— 9·1	+ 7·3	+14·3	—5·3	+14·9	—12·8	14 45	6 41	+16·5	—12·8	29·3
ary . .	—11·3	+ 8·0	+13·8	—6·3	+15·2	—13·4	13 54	5 37	+16·0	—14·6	30·6
. .	— 9·1	+ 4·6	+11·8	—4·5	+12·8	—10·7	14 17	5 30	+14·1	—12·8	26·9
. .	—11·6	+ 5·8	+12·3	—5·4	+13·1	—14·1	14 27	5 31	+14·6	—14·6	29·2
. .	—11·6	+ 5·9	+11·6	—4·6	+13·9	—13·3	14 7	5 25	+15·6	—13·9	29·5
. .	— 8·3	+ 1·8	+ 8·4	—3·8	+ 9·7	— 9·7	14 43	5 2	+11·8	—10·0	21·8
. .	— 3·9	+ 1·3	+ 4·7	—1·6	+ 5·2	— 4·0	14 42	4 50	+ 8·4	— 5·4	13·8
ist . .	— 3·9	+ 1·3	+ 4·7	—1·7	+ 6·5	— 4·0	14 34	5 0	+ 7·7	— 4·9	12·6
mber .	— 6·7	+ 2·6	+ 8·0	—3·0	+ 8·4	— 7·4	14 30	5 37	+10·5	— 8·0	18·5
ber . .	—10·7	+ 7·0	+13·5	—6·0	+14·6	—11·6	14 12	5 39	+16·1	—12·7	28·8
mber .	—13·4	+13·0	+16·5	—6·9	+18·0	—15·2	14 4	6 19	+19·2	—15·8	35·0
mber .	— 9·8	+ 7·7	+14·4	—5·7	+16·7	—10·3	14 54	6 34	+16·7	—12·9	29·6
Year .	— 9·1	+ 5·5	+11·1	—4·6	+12·3	—10·5	14 26	5 39	+13·9	—11·5	25·5

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: ROORKEE.

Latitude, 29° 52′ N.; Longitude, 77° 56′ E.; Elevation, 887 feet.
Data—
Hourly observations . . . . 24 days each month.
Six hourly " . . . . 7-8 years (in addition).
10 & 16 hours observations . . 5-6 "
Maxima and Minima . . . . 14 "

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	— 9·4	+2·3	+11·8	—2·7	+13·1	—10·9	14 30	6 43	+14·6	—12·3	26·9
February . .	— 9·2	+3·0	+11·4	—3·2	+12·6	—10·6	14 30	6 30	+14·0	—11·6	25·6
March . .	—11·2	+5·1	+12·6	—4·0	+13·5	—12·2	14 30	5 46	+15·2	—13·8	29·0
April . .	—12·0	+6·7	+12·9	—4·4	+13·7	—13·5	14 36	5 15	+15·6	—15·5	31·1
May . .	—12·4	+5·7	+12·0	—3·8	+12·5	—13·2	14 45	5 0	+14·7	—14·0	28·7
June . .	— 8·7	+2·8	+ 8·0	—2·7	+10·0	— 9·6	14 30	5 6	+11·8	—10·7	22·5
July . .	— 5·0	+1·3	+ 5·4	—1·6	+ 6·6	— 5·6	15 30	5 3	+ 8·2	— 6·3	14·5
August . .	— 4·9	+2·1	+ 6·1	—1·8	+ 6·2	— 5·4	15 20	5 10	+ 7·9	— 5·8	13·7
September . .	— 6·7	+3·3	+ 7·3	—3·1	+ 8·6	— 7·5	14 0	5 37	+10·1	— 8·2	18·3
October . .	—10·4	+6·6	+12·3	—4·8	+14·3	—11·5	14 30	6 3	+15·2	—12·9	28·1
November . .	—12·1	+7·4	+14·1	—5·5	+16·7	—12·8	14 10	6 0	+18·1	—14·7	32·8
December . .	— 9·8	+4·5	+12·4	—4·2	+14·7	—10·7	14 30	6 30	+16·5	—12·7	29·2
Year . .	— 9·4	+4·2	+10·6	—3·5	+11·8	—10·3	14 37	5 44	+13·5	—11·5	25·0

STATION: AGRA.

Latitude, 27° 10′ N.; Longitude, 78° 5′ E.; Elevation, 555 feet.
Data—
Hourly observations . . . . 24 days each month.
Six hourly " . . . . 7-8 years.
10 & 16 hours observations . . 5-6 " (in addition).
Maxima and Minima . . . . 12-14 "

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	— 6·7	+1·3	+10·8	—1·2	+11·6	—10·9	14 45	6 46	+12·8	—10·9	23·7
February . .	— 8·0	+1·3	+11·4	—1·1	+11·6	—11·8	15 1	6 31	+13·2	—11·8	25·0
March . .	— 9·9	+2·9	+12·7	—1·2	+13·0	—12·6	15 33	5 59	+14·6	—12·6	27·2
April . .	—10·6	+3·4	+11·8	—2·0	+12·0	—13·0	15 33	5 43	+13·9	—13·7	27·6
May . .	— 9·5	+3·0	+10·1	—2·2	+10·5	—10·7	15 14	5 26	+12·9	—12·2	25·1
June . .	— 6·7	+2·0	+ 7·1	—1·5	+ 7·5	— 8·0	14 36	5 27	+10·1	— 8·9	19·0
July . .	— 3·7	+0·9	+ 3·9	—0·8	+ 4·7	— 3·4	13 57	5 31	+ 5·4	— 5·9	11·3
August . .	— 3·5	+0·6	+ 3·6	—0·7	+ 5·0	— 4·8	14 14	5 42	+ 5·9	— 5·8	11·7
September . .	— 4·3	+1·4	+ 5·0	—1·2	+ 5·4	— 5·7	14 57	5 52	+ 6·9	— 6·5	13·4
October . .	— 7·4	+2·2	+10·4	—2·5	+10·2	—10·0	14 38	6 19	+11·8	—10·6	22·4
November . .	— 9·6	+3·3	+12·7	—2·7	+13·3	—11·7	15 22	6 23	+14·0	—12·5	26·5
December . .	— 7·6	+2·0	+10·9	—1·4	+11·4	—10·7	14 51	6 40	+12·5	—11·6	24·1
Year . .	— 7·3	+2·0	+ 9·2	—1·6	+ 9·7	— 9·5	14 54	6 2	+11·2	—10·3	21·4

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: JHANSI.

Latitude, 25° 27' N.; on, 855 feet.
Data.—

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
y . .	— 9·7	+ 3·2	+11·1	— 0·9	+12·2	—11·7	14 30	6 32	+18·5	—12·5	26·0
ry . .	—10·8	+ 3·3	+11·5	— 1·1	+12·6	—12·0	14 35	6 5	+18·0	—12·6	26·6
. .	—11·3	+ 4·1	+12·2	— 1·3	+12·7	—13·7	14 38	5 43	+14·6	—13·7	28·3
. .	—11·6	+ 4·8	+11·8	— 2·2	+12·5	—13·6	14 40	5 37	+14·7	—13·5	28·2
. .	—10·5	+ 3·7	+10·0	— 2·3	+10·7	—11·6	14 13	6 25	+18·6	—12·8	26·4
. .	— 5·9	+ 2·4	+ 6·3	— 1·9	+ 7·8	— 6·8	14 10	5 37	+12·0	— 9·0	21·0
. .	— 3·8	+ 1·3	+ 4·5	— 1·2	+ 5·1	— 4·5	14 15	5 35	+ 8·0	— 5·2	13·8
. .	— 4·0	+ 2·1	+ 3·8	— 1·5	+ 5·3	— 4·4	14 0	5 24	+ 7·6	— 5·6	13·2
ber .	— 6·0	+ 3·1	+ 6·3	— 2·1	+ 7·1	— 6·4	14 4	5 33	+ 8·7	— 6·7	15·4
r . .	—10·7	+ 5·7	+ 9·9	— 1·6	+11·5	—11·0	14 6	5 30	+12·8	—12·0	24·8
ber .	—11·8	+ 6·3	+11·8	— 0·5	+13·8	—13·4	13 58	5 41	+14·7	—14·1	28·8
ber .	—11·9	+ 5·1	+11·0	— 0·2	+13·2	—12·5	13 54	6 0	+13·6	—12·9	26·5
Year .	— 9·0	+ 3·8	+ 9·2	— 1·4	+10·4	—10·2	14 15	5 41	+12·3	—10·9	23·3

STATION: LUCKNOW.

Latitude, 26° 50' N.; Longitude, 81° 0' E.;
Data.— Hourly observations
Six hourly "
10 & 16 hours observations
Maxima and Minima

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum	Periodic Minimum.	Time of Maximum	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
ry . .	—10·2	+ 2·8	+11·2	— 3·8	+12·4	—13·4	14 43	6 40	+13·7	—15·2	28·9
ary .	—10·8	+ 4·1	+13·1	— 2·8	+13·1	—12·2	15 0	6 4	+14·6	—14·5	29·1
. .	—12·4	+ 5·8	+13·5	— 2·6	+14·0	—14·0	14 40	5 42	+15·6	—16·1	31·7
. .	—13·4	+ 6·4	+12·9	— 4·3	+13·9	—14·7	14 45	5 29	+15·6	—16·8	32·4
. .	—10·8	+ 4·0	+11·0	— 2·5	+11·4	—11·5	15 7	5 0	+13·9	—13·7	27·6
. .	— 9·0	+ 2·4	+ 7·8	— 1·9	+ 8·3	— 8·6	14 30	5 6	+12·3	—10·4	21·7
. .	— 4·2	+ 2·0	+ 4·9	— 1·5	+ 5·6	— 4·7	14 4	5 35	+ 8·4	— 6·0	14·4
st . .	— 4·3	+ 1·6	+ 4·8	— 1·6	+ 5·7	— 4·9	13 48	5 38	+ 7·5	— 6·0	13·5
mber .	— 4·8	+ 3·0	+ 6·2	— 1·9	+ 6·2	— 5·8	13 54	5 38	+ 8·8	— 7·0	15·8
ber . .	— 9·8	+ 6·2	+11·1	— 4·2	+12·1	—11·3	14 8	5 42	+14·0	—12·4	26·4
mber .	—11·8	+ 7·3	+14·0	— 5·1	+15·8	—12·7	14 20	6 43	+17·3	—15·7	33·0
mber .	—10·6	+ 6·0	+13·5	— 3·9	+16·2	—12·7	14 27	6 21	+17·0	—14·4	31·4
Year .	— 9·3	+ 4·3	+10·3	— 3·1	+11·1	—10·5	14 27	5 43	+13·1	—12·1	25·5

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: ALLAHABAD.

Latitude, 25° 26′ N.; Longitude, 81° 52′ E.; Elevation, 307 feet.
Data—
Hourly observations. 24 days each month.
Six hourly ,, 12 years.
Maxima and Minima. 12 ,,

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January	− 9·4	+ 4·0	+12·3	− 3·8	+14·0	−10·5	14 13	6 46	+14·8	−11·5	26·3
February	−11·0	+ 4·9	+13·5	− 4·1	+14·5	−12·5	14 10	6 5	+15·3	−13·0	28·3
March	−12·5	+ 6·5	+14·0	− 4·4	+15·0	−13·9	14 23	5 47	+16·5	−15·1	31·6
April	−13·4	+ 7·8	+13·5	− 4·7	+14·8	−15·0	14 4	5 21	+16·5	−15·8	32·3
May	−11·6	+ 5·2	+11·4	− 4·3	+12·8	−12·3	14 0	5 5	+14·6	−14·0	28·6
June	− 7·0	+ 3·7	+ 7·7	− 3·9	+ 9·7	− 7·4	14 7	4 50	+12·0	− 8·6	20·6
July	− 4·0	+ 2·2	+ 4·1	− 1·6	+ 5·1	− 4·3	14 13	5 0	+ 7·7	− 5·2	12·9
August	− 3·5	+ 2·3	+ 3·0	− 1·4	+ 4·8	− 4·0	14 3	5 30	+ 6·0	− 4·6	11·5
September	− 4·3	+ 3·2	+ 4·9	− 2·2	+ 6·8	− 5·2	13 47	5 44	+ 8·1	− 6·5	13·6
October	− 8·2	+ 6·0	+ 9·8	− 4·4	+12·2	− 9·2	13 45	5 53	+12·7	− 9·7	22·4
November	−10·0	+ 7·2	+12·8	− 4·9	+14·6	−10·3	14 9	6 2	+15·4	−12·1	29·5
December	− 9·8	+ 5·7	+12·6	− 4·6	+15·2	−10·5	13 52	6 12	+16·1	−11·3	27·4
Year	− 8·7	+ 4·9	+10·0	− 3·6	+11·6	− 9·6	14 3	5 43	+13·2	−10·5	23·7

STATION: GORAKHPUR.

Latitude, 26° 46′ N.; Longitude, 83° 18′ E; Elevation, 256 feet.
Data—
Hourly observations. 24 days each month (at Lucknow).
Six hourly ,, 6-7 years.
10 hours & 16 hours observations. 6 additional years.
Maxima and Minima. 12 years.

Month.	4 hours.	10 hours	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January	− 9·4	+ 4·5	+12·4	− 3·0	+13·6	−12·2	14 40	6 39	+14·7	−12·2	26·9
February	−10·5	+ 4·7	+12·5	− 3·4	+13·0	−11·8	14 30	6 0	+15·1	−11·9	27·0
March	−11·2	+ 5·4	+12·5	− 3·5	+13·3	−13·3	14 30	5 47	+15·0	−13·9	28·9
April	−11·5	+ 4·4	+12·2	− 3·4	+12·8	−13·7	14 37	5 36	+14·7	−14·4	29·1
May	− 9·1	+ 3·0	+10·1	− 2·5	+10·5	−10·1	15 7	5 18	+13·1	−11·3	24·4
June	− 5·6	+ 1·0	+ 7·0	− 1·9	+ 7·3	− 7·2	14 45	5 38	+ 9·7	− 8·5	18·2
July	− 3·7	+ 1·7	+ 4·4	− 1·3	+ 5·2	− 4·1	14 0	5 41	+ 8·5	− 5·5	14·0
August	− 3·5	+ 1·6	+ 3·7	− 1·4	+ 5·0	− 6·1	13 30	5 45	+ 6·6	− 5·7	12·3
September	− 3·6	+ 2·0	+ 4·8	− 1·6	+ 5·6	− 5·1	14 0	5 47	+ 7·5	− 6·2	13·7
October	− 6·9	+ 4·5	+ 8·9	− 3·3	+10·0	−10·1	14 6	5 51	+11·1	− 9·4	20·5
November	− 9·0	+ 5·7	+12·4	− 4·7	+14·2	−11·3	14 20	6 0	+14·7	−11·8	26·5
December	− 7·1	+ 4·4	+12·0	− 4·2	+13·6	−11·7	14 21	6 37	+14·6	−11·7	26·3
Year	− 7·6	+ 3·6	+ 9·4	− 3·8	+10·3	− 9·8	14 27	5 53	+12·1	−10·2	22·3

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: PATNA.

Latitude, 25° 37′ N.; Longitude, 85° 8′ E.; Elevation, 179 feet.
Data— Hourly observations, 27-29 days each month.
Six hourly, 4-5 years.
Maxima and Minima, 5 ,,

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
ry .	— 9·0	+5·5	+11·2	—4·2	+12·0	—10·1	14 30	5 30	+12·4	—11·2	23·6
ary .	—10·6	+6·1	+11·7	—4·8	+12·6	—11·7	14 22	5 20	+13·6	—12·7	26·3
.	—12·3	+7·1	+13·1	—5·2	+13·9	—12·9	14 22	5 15	+14·2	—14·6	28·8
.	—11·7	+5·9	+12·2	—4·4	+12·9	—12·4	14 48	5 8	+14·4	—14·5	28·9
.	—10·2	+5·1	+10·7	—4·0	+11·2	—10·5	14 57	4 38	+13·3	—10·5	23·8
.	— 6·8	+3·4	+ 7·4	—2·9	+ 7·8	— 7·0	14 56	4 43	+11·0	— 7·6	18·6
.	— 3·7	+2·4	+ 3·6	—1·7	+ 4·3	— 3·8	13 15	4 30	+ 7·3	— 4·8	12·1
t .	— 3·6	+2·3	+ 3·6	—1·6	+ 3·9	— 3·9	14 45	4 48	+ 6·5	— 4·2	10·7
nber .	— 3·7	+2·4	+ 3·7	—1·7	+ 4·7	— 3·9	13 45	4 54	+ 6·8	— 4·8	11·6
er .	— 5·9	+5·0	+ 6·1	—3·3	+ 7·4	— 6·8	13 58	5 30	+ 8·5	— 7·8	16·3
nber .	— 9·0	+7·3	+ 9·5	—4·7	+11·5	—10·3	13 42	5 37	+12·3	—11·7	24·0
ber .	—10·0	+6·4	+10·2	—4·8	+12·1	—10·4	14 0	5 0(?)	+12·4	—12·2	24·6
Year .	— 8·1	+4·9	+ 8·6	—3·6	+ 9·5	— 8·6	14 17	5 8	+11·1	— 9·7	20·8

STATION: HAZARÍBAGH.

Latitude, 24° 0′ N.; Longitude, 85° 21′ E.; Elevation, 2,010 feet.
Data— Hourly observations, 33-96 days each month.
Maxima and Minima, 6 years.

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
ary .	— 8·0	+1·5	+10·3	—4·0	+11·2	— 9·0	14 37	6 18	+11·3	—11·2	23·0
uary .	— 8·5	+1·6	+10·7	—3·7	+11·4	— 9·7	14 25	5 52	+12·4	—10·9	23·3
h .	—10·0	+3·0	+ 9·8	—4·0	+11·4	—11·0	14 30	5 38	+12·7	—13·0	25·7
.	— 9·5	+2·5	+ 9·8	—3·6	+10·8	—11·0	14 10	5 35	+12·5	—12·6	25·1
.	— 9·3	+2·0	+ 8·5	—3·7	+10·0	— 9·7	14 13	4 51	+11·7	—11·7	23·4
.	— 5·2	+1·3	+ 4·9	—2·5	+ 6·3	— 5·5	13 38	4 56	+ 8·9	— 6·1	16·5
.	— 2·0	+0·6	+ 3·0	—1·5	+ 4·1	— 3·2	13 54	5 15	+ 6·1	— 5·2	11·3
ust .	— 3·0	+1·0	+ 2·6	—1·4	+ 3·6	— 3·3	13 30	5 24	+ 5·5	— 5·3	10·8
ember .	— 4·3	+1·3	+ 4·3	—2·1	+ 6·0	— 4·5	13 18	5 10	+ 6·5	— 5·8	12·3
ber .	— 5·3	+2·9	+ 6·3	—3·2	+ 7·5	— 6·6	14 25	5 30	+ 8·3	— 8·0	16·3
ember .	— 7·0	+3·3	+ 8·2	—4·0	+ 9·4	— 7·8	14 20	5 34	+10·3	—10·4	20·7
ember .	— 7·8	+2·0	+ 9·5	—3·0	+10·9	— 8·7	14 34	5 54	+11·4	—11·3	22·6
Year .	— 6·8	+1·9	+ 7·3	—3·1	+ 8·6	— 7·5	14 7	5 31	+ 9·8	— 9·5	19·3

Table I—Diurnal variation of Temperature—contd

STATION JUBBULPORE.

Latitude 23° 9 N
Data—
Longitude 79° 59 E Elevation, 1,351 feet
Hourly observations 24 days each month
Maxima and Minima, 5 years

Month	4 hours.	10 hours	16 hours	22 hours.	Periodic Maximum.	Periodic Minimum	Time of Maximum	Time of Minimum	Self registered Maximum	Self registered Minimum	Mean daily Range
	°	°	°	°	°	°	H M	H. M	°	°	°
January	−11 8	+3 4	+14 4	−3 1	+14 9	−13 0	14 47	6 17	+16 2	−14 0	30 2
February	−11 4	+3 4	+13 1	−2 4	+13 9	−13 1	14 56	6 4	+15 5	−13 9	29 4
March	−13 0	+4 4	+13 9	−2 9	+14 3	−14 3	14 52	5 43	+15 8	−15 7	31 5
April	−12 7	+5 2	+12 2	−3 1	+13 1	−14 2	14 30	5 32	+14 6	−15 4	30 0
May	−11 6	+5 1	+10 7	−3 0	+11 6	−11 8	14 7	4 50	+14 0	−12 1	26 1
June	− 6 8	+3 0	+ 6 5	−3 0	+ 3 7	− 6 4	14 0	5 0	+11 1	− 8 5	19 6
July	− 3 5	+1 2	+ 3 9	−1 4	+ 5 4	− 3 9	14 17	5 35	+ 7 0	− 4 7	11 7
August	− 3 5	+1 3	+ 3 8	−1 6	+ 4 6	− 3 7	14 30	5 36	+ 6 6	− 4 0	10 6
September	− 5 0	+2 7	+ 5 3	−2 2	+ 6 6	− 5 5	14 5	5 39	+ 7 5	− 5 0	12 5
October	− 9 3	+5 3	+ 9 9	−3 3	+11 7	−10 5	14 37	5 41	+12 4	−10 0	22 4
November	−12 1	+6 5	+13 6	−3 6	+14 5	−13 5	14 30	5 42	+15 9	−14 7	30 6
December	−11 7	+4 8	+14 2	−3 6	+15 4	−13 5	14 24	6 3	+16 3	−14 0	30 3
Year	− 9 3	+3 9	+10 1	−2 8	+11 2	−10 3	14 28	5 39	+12 7	−11 0	23 7

STATION NAGPUR

Latitude 21° 0 N
Data—
Longitude 79° 11 E. Elevation, 1,025 feet
Hourly observations 24—28 days each month
Maxima and Minima, 6 years

Month	4 hours	10 hours	16 hours	22 hours	Periodic Maximum	Periodic Minimum	Time of Maximum	Time of Minimum	Self registered Maximum	Self registered Minimum	Mean daily Range
	°	°	°	°	°	°	H M	H M	°	°	°
January	−10 8	+3 0	+13 9	−4 1	+14 4	−12 8	15 10	6 37	+15 4	−13 3	28 7
February	−10 8	+4 2	+13 7	−3 1	+14 0	−13 3	15 17	6 13	+15 4	−13 9	29 3
March	−11 7	+5 2	+13 7	−4 2	+13 8	−13 2	15 0	5 43	+15 7	−16 5	32 2
April	−12 1	+5 4	+11 7	−4 4	+13 0	−13 9	14 39	5 31	+14 7	−14 9	29 6
May	−10 6	+5 3	+10 6	−4 7	+12 7	−12 0	14 30	5 33	+14 5	−13 1	27 6
June	− 7 0	+2 8	+ 7 6	−2 4	+ 8 8	− 7 6	14 39	4 58	+13 2	− 8 6	21 8
July	− 4 0	+2 2	+ 4 0	−1 6	+ 4 4	− 4 4	14 0	5 33	+ 8 1	− 6 0	14 1
August	− 4 3	+2 7	+ 4 0	−1 9	+ 5 4	− 4 8	13 0	5 30	+ 7 3	− 6 2	13 5
September	− 5 5	+3 4	+ 6 0	−2 7	+ 7 2	− 6 1	13 15	5 13	+ 8 4	− 7 1	15 5
October	− 9 2	+6 1	+ 9 3	−4 0	+10 8	−10 4	13 30	5 35	+10 1	−11 3	21 4
November	− 9 5	+5 4	+11 1	−4 2	+11 8	−11 6	14 30	5 45	+12 8	−13 7	26 5
December	−10 8	+4 8	+13 1	−4 3	+13 8	−12 2	14 43	5 53	+14 8	−12 8	27 6
Year	− 8 9	+4 2	+ 8 9	−3 5	+10 8	−10 2	14 21	5 40	+12 5	−11 4	24 0

TABLE I.—*Diurnal variation of Temperature*—concld

STATION PACHMARHI.

Latitude 22° 28 N., Longitude, 78° 28 E., Elevation 3,501 feet
Data—Hourly observations, 24—28 days each month
Maxima and Minima, 6 years

ionth	4 hours	10 hours	16 hours	22 hours	Periodic Maximum	Periodic Minimum	Time of Maximum		Time of Minimum		Self registered Maximum	Self registered Minimum	Mean daily Range
	°	°	°	°	°	°	H	M	H	M	°	°	°
y	−9·5	+8·1	+11·8	−6·1	+12·7	−9·9	14	20	5	43	+14·4	−9·8	24·3
ry	−9·3	+5·7	+10·4	−4·5	+11·1	−10·1	14	43	5	2	+12·3	−11·0	23·3
	−8·2	+5·2	+8·9	−4·6	+9·7	−8·7	14	30	5	30	+10·5	−13·5	24·0
	−7·7	+3·9	+8·4	−3·1	+8·5	−9·1	15	30	5	35	+10·1	−12·3	22·4
	−6·9	+2·4	+7·6	−2·4	+8·1	−7·7	14	15	5	32	+10·0	−9·0	19·0
	−4·3	+0·1	+5·5	−C·0	+5·6	−5·2	15	30	5	42	+8·1	−6·4	14·5
	−2·1	+0·3	+2·6	−0·2	+2·9	−2·5	14	7	5	30	+3·9	−4·3	8·2
t	−2·4	+0·3	+2·9	−0·3	+3·3	−2·9	15	0	5	47	+4·9	−2·5	7·4
ober	−3·6	+2·1	+3·8	−1·6	+5·2	−4·2	13	30	5	37	+6·1	−4·0	10·1
r	−7·9	+6·5	+7·4	−3·4	+8·0	−8·7	13	55	5	33	+9·1	−8·2	17·3
ber	−8·9	+8·2	+10·1	−5·5	+11·0	−10·2	13	55	5	38	+10·2	−11·7	21·9
ber	−9·1	+5·8	+10·1	−6·0	+11·8	−9·8	13	20	5	35	+12·8	−11·6	24·4
Year	−6·7	+4·3	+7·5	−3·1	+8·2	−7·4	14	23	5	34	+9·1	−8·7	18·1

At most stations, especially where the hourly means for a few days in each month been corrected by the insertion of the six-hourly means for several years, the epochs maximum and minimum, and the variations from the means at these epochs and at hours given in the table, exhibit a fairly regular annual inequality. The most impor- exception to this rule is Patna, where the hour of minimum is apparently very gular, probably owing to some defect in the observations. The epoch of minimum es with the hour of sunrise, generally preceding it by a quarter to half an hour; on the whole, occurring earlier, as the elevation of the station is greater. The co- dence of the periodic minimum with sunrise, at stations on the plains, would be closer, were assumed, as was done in discussing the temperature of Allahabad, (Vol. I, page), that there is a sudden break in the curve at the minimum, and that the parts of the ve, for an hour or two before and after this break, may be regarded as straight lines every station on the plains, except Kurrachee, the maximum occurs between 2 and 3 on the mean of the year; the earlier hour of its occurrence at Kurrachee being ually due to the sea breeze. On most parts of the plain, with the apparent exception of orkee, the maximum occurs later in the months when west-winds blow, than when wind is easterly or the air calm. At the hill stations, the maximum is reached sooner he afternoon than in the plains; especially at places like Chakrata, situated on a narrow ge, in the inner zone of the mountains, and fully exposed to the diurnal mountain ids. At Leh, in the Upper Indus Valley, the maximum occurs before 2 P.M. in winter; , in June, it is not reached until 3 hours 26 minutes P.M.; being almost as much

retarded as at any place on the plains. The high latitude of Leh doubtless tends in summer, when the days are lengthened in consequence, to render the maximum considerably later than it would be at a place, of the same elevation, further south.

The range, indicated by self-recording thermometers is, in every case, considerably in excess of the periodic range; particularly in the rainy season, when the maximum temperature is subject to sudden and irregular changes, owing to the sun breaking through the clouds, for short periods, at uncertain hours of the day. The periodic and aperiodic minima do not differ so much as the maxima; and, at several of the stations, the two are identical in the clear still nights of the cold weather. The ratios of the aperiodic to the periodic ranges, on the mean of all the stations in Table I, except the first three, are the following:—

January	February	March.	April.	May.	June.	July	August.	September	October	November.	December	Year
1·09	1·09	1·13	1·13	1 17	1 26	1 62	1·26	1 17	1 07	1·10	1·11	1 14

Diurnal Range (Aperiodic).

The stations in Table I being few in number, while equally good observations of the daily range have been made at all the Government observatories and some others, the whole of the comparable values of this important climatological factor are given in Table II. The number of years, on which the means are founded, is not mentioned in this table; but the figures are, for the most part, taken from the reports of the year 1875—80, only those years being included, in which the thermometers were exposed under thatched sheds. The ranges at Agra, Delhi and Bickaneer are less than they ought to be, owing to the situation of the observatories in the interior of large towns; and there is probably some error in the same direction at Lahore.

Table II.—*Mean Diurnal Range of Temperature.*

Stations	January	Feb	March	April.	May.	June.	July.	August	Sept.	October	Nov	Dec	Year.
Yarkand . . .	22·6	..	...	29 8	30·0	30 2	28·1	...	...	25·0	25·9	24·3	...
Gilgit	19 8	19 3	21·2	20·4	23·8	28·6	25·4	24·4	25·2	23 4	...	23 0	...
Leh	23 5	23 6	21·0	25·7	20·7	27·2	27·4	25 4	27·1	26 1	24 8	22 7	25 2
Murree . . .	12 6	12·9	15·0	15 7	16 5	17 2	15·9	14 6	15·4	16 5	15·4	12 6	15 0
Simla . . .	18 7	19 3	19 8	21·9	21 9	20·4	14·7	14·3	16·8	19 3	19 4	18·5	18 8
Chakrâta . .	15 3	15 1	17 1	17·9	17 4	15 1	10·4	9 4	11 0	14 6	15 3	15 7	14·5
Mussooree . .	11 0	13 2	14 0	16·0	16 3	15 2	9 4	8 2	10·3	12·8	10·3	12 3	13 1
Dehra . . .	22 6	22 1	23 8	25 1	23·3	19·7	12·2	11·9	14·5	21·0	23 8	22 7	20·2
Pauri . . .	15 3	16·2	19 5	20·7	20·8	12·7	11·9	9 3	11·3	18·4	18·2	17·3	15 9

TABLE II.—*Mean Diurnal Range of Temperature*—contd.

Stations.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Year.
Ranikhet	15·2	15·3	17·3	17·4	17·1	13·8	10·7	9·3	12·3	14·9	16·3	15·6	14·6
Naini Tal	15·8	16·7	16·7	17·9	15·9	11·4	9·3	10·9	10·2	16·0	18·5	18·3	14·8
Pithoragarh	19·0	18·8	20·5	20·5	19·7	15·2	15·4	12·9	14·1	20·4	20·7	22·8	18·4
Katmandu	30·5	29·2	26·0	31·2	23·3	19·6	13·8	18·0	19·6	24·4	32·5	34·5	25·8
Quetta	27·8	21·4	25·1	23·6	30·0	29·4	27·2	26·8	33·9	35·8	36·5	29·4	29·4
Jacobabad	33·6	28·7	31·6	32·3	32·1	27·5	24·2	22·2	25·5	32·0	33·8	31·8	29·7
Hyderabad	28·8	25·2	30·0	30·5	28·8	22·3	19·5	15·6	20·8	26·1	27·7	26·4	25·1
Kurrachee	24·3	24·5	22·3	19·3	16·0	13·4	11·2	10·4	13·0	21·6	27·4	26·2	19·1
Bhuj	25·6	25·4	29·0	28·7	24·4	17·7	13·5	13·4	15·8	22·7	25·0	26·3	22·2
Rajkot	34·2	33·2	35·5	33·3	29·4	20·9	15·8	15·0	17·1	26·8	31·7	32·2	27·1
Deesa	30·6	31·2	31·1	30·7	27·0	20·8	14·3	11·8	16·4	28·1	33·1	32·2	25·6
Surat	31·0	31·2	32·4	28·2	20·8	14·8	11·4	11·0	12·9	21·1	27·3	28·6	22·5
Malegaon	35·1	35·3	36·1	32·7	28·1	21·4	14·7	12·0	16·2	26·4	29·5	31·7	26·6
Khandwa	32·2	33·7	33·2	30·9	26·5	21·3	14·0	13·2	15·0	25·2	31·2	32·2	25·7
Chikalda	16·6	18·9	19·1	20·5	20·4	16·9	9·1	8·1	9·5	12·9	15·0	16·1	15·3
Buldana	20·5	21·2	21·4	21·3	21·4	18·2	13·3	12·8	12·4	15·2	19·0	19·9	18·1
Akola	31·8	32·5	33·4	32·0	26·2	22·1	15·8	15·1	18·5	24·8	30·9	30·2	25·9
Amraoti	28·2	29·4	30·9	31·4	28·4	21·8	15·3	14·8	16·4	23·6	26·7	27·0	24·4
Pachmarhi	24·3	23·3	24·0	22·4	19·0	14·5	8·2	7·4	10·1	17·3	21·9	24·4	18·1
Hoshangabad	28·8	29·0	32·4	30·9	27·0	20·2	11·6	11·8	14·5	21·6	27·2	27·0	23·5
Jubbulpore	30·2	29·4	31·5	30·0	26·1	19·6	11·7	10·6	12·5	22·4	30·6	30·3	23·7
Seoni	20·7	29·1	30·9	31·1	27·0	20·3	13·3	12·5	14·6	21·2	26·8	27·5	23·7
Nágpur	28·7	29·3	32·2	29·6	27·6	21·8	14·1	13·5	15·5	21·4	26·5	27·6	24·0
Chánda	31·3	31·1	31·8	27·9	25·3	17·8	13·4	13·0	14·6	20·4	27·2	29·8	23·6
Raipur	26·4	26·0	29·2	26·8	24·9	19·6	12·6	11·5	13·2	17·2	22·4	24·7	21·1
Sambalpur	27·5	26·2	31·5	28·9	25·7	17·6	11·0	11·3	13·4	16·9	22·7	25·4	21·5
Neemuch	30·2	27·8	29·7	23·4	25·0	21·1	18·9	12·2	16·1	24·4	28·8	27·8	23·4
Indore	26·8	29·0	32·4	31·6	25·8	19·8	12·0	10·9	11·5	20·6	23·0	26·4	22·5
Jhansi	26·0	26·6	28·3	28·2	26·4	21·0	13·8	13·2	15·4	24·8	28·8	26·5	23·3
Saugor	22·9	24·0	28·2	29·4	26·3	22·8	12·5	12·4	15·3	21·4	23·8	24·1	21·0
Nowgong	30·7	29·6	33·2	32·5	26·8	19·4	12·3	11·8	15·2	26·6	31·8	30·0	25·0
Satna	27·2	26·3	30·7	29·0	24·9	19·1	13·5	10·4	12·5	21·2	27·2	28·5	22·6
Hazaribagh	23·0	23·3	25·7	25·1	23·4	16·9	11·3	10·8	12·3	16·3	20·7	22·6	19·3
Gya	24·2	24·9	29·7	29·6	26·8	23·1	13·3	12·4	13·2	17·2	23·7	25·0	21·9
Patna	23·6	26·3	28·8	28·9	23·8	18·6	12·1	10·7	11·6	16·3	24·6	24·6	20·8

Mean Diurnal Range of Temperature—contd.

Stations.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Gorakhpur	26·9	27·0	28·0	29·1	24·4	18·2	14·0	12·3	13·7	20·5	26·5	26·3	22·3
Benares	28·1	29·2	31·0	31·0	25·8	20·0	13·0	11·9	14·3	22·0	28·3	28·4	23·6
Allahabad	26·3	28·8	31·6	32·3	28·6	20·6	12·9	11·5	13·6	22·4	28·5	27·4	23·7
Lucknow	28·9	29·1	31·7	32·4	27·6	21·7	14·1	13·5	15·8	26·4	33·0	31·4	25·5
Bareilly	25·7	24·8	27·9	29·6	27·2	21·6	15·7	13·2	15·4	22·9	29·4	26·9	23·4
Futehgarh	26·7	27·8	28·6	31·1	28·4	21·2	13·7	12·0	14·0	27·2	31·8	28·4	24·3
Agra	23·7	25·0	27·2	27·6	25·1	19·0	11·3	11·7	13·4	22·4	26·5	24·1	21·4
Delhi	23·6	22·2	25·8	26·0	21·9	20·9	14·6	14·7	16·7	22·4	26·4	24·2	21·8
Meerut	23·0	26·6	29·2	30·0	27·3	22·6	14·5	14·0	17·4	26·6	31·9	29·9	24·7
Roorkee	26·9	25·6	29·0	31·1	28·7	22·5	14·0	13·7	18·5	28·1	32·8	29·2	25·0
Joypur	29·3	30·6	26·9	29·2	29·5	21·8	13·8	12·6	18·5	28·8	35·0	29·6	25·5
Sambhar	31·8	20·6	23·0	25·0	25·8	18·9	13·8	13·8	18·0	26·0	31·5	29·8	24·1
Ajmere	32·4	31·2	32·8	31·4	28·6	22·6	16·6	14·9	19·8	30·4	34·8	33·4	27·4
Mount Abu	18·1	16·6	17·6	17·7	17·8	16·2	10·3	9·2	10·7	14·9	17·1	17·5	15·3
Pachbadra	33·0	33·8	41·3	37·0	30·6	24·1	18·5	18·5	24·3	32·2	38·7	36·4	31·1
Bickaneer	27·5	24·6	25·5	24·7	21·3	20·6	16·6	14·8	18·0	23·1	26·4	25·4	22·6
Sirsa	29·8	27·4	31·7	31·0	29·0	23·3	19·1	18·6	23·4	32·5	34·4	30·1	27·5
Ludhiana	27·7	24·5	27·4	30·1	28·7	26·7	16·6	15·8	19·3	25·8	28·6	27·3	24·8
Lahore	27·4	24·5	26·0	30·3	29·0	27·3	19·5	17·9	20·5	28·2	30·4	27·9	25·8
Mooltan	29·3	27·6	29·3	31·3	29·2	25·6	21·9	19·6	23·6	29·1	28·2	29·0	26·9
Dera Ismail Khan	29·5	25·6	27·9	27·7	27·0	26·1	21·1	20·1	24·7	30·0	31·8	30·3	26·8
Sialkot	26·8	21·9	28·6	30·4	27·6	25·6	17·5	16·2	21·5	27·1	33·0	28·5	25·4
Rawal Pindi	26·2	23·4	26·8	28·6	28·8	29·9	22·4	20·5	27·8	31·8	33·0	29·6	27·4
Peshawar	27·4	24·2	26·4	26·5	28·7	29·2	21·8	21·0	26·5	29·7	30·9	28·4	27·0
Thull	30·1	23·0	31·8	28·7	25·9	24·2	20·8	22·4	25·1	32·4	30·3	...	..

In the Himalaya, with the apparent exception of Katmandu, where there is probably some unascertained peculiarity in the exposure of the thermometers, the daily range of temperature diminishes from the plains, up to an elevation of 5,000 or 6,000 feet; above which it appears to increase again. This increase is, however, probably owing to the highest station, Leh, being situated in the arid region, behind the snowy ranges of the Himalaya proper; for Gilghit, in a similar situation, and at an elevation between 5,000 and 6,000 feet, has a range nearly or quite as great as Leh. In Central India and Rajputana also, the ranges at hill stations, such as Chikalda, Pachmarhi, and Mount Abu, are much less than at adjacent stations of lower elevation, like Akola, Hoshangabad and Deesa. In Afghanistan and Beluchistan, however, and probably on table-lands generally, this rule does not hold; the range at Quetta being equal to that of Jacobabad. The

diminished range at hill stations, compared with places on the plains, is due to causes well understood—the downward movement of the air, cooled by radiation, from the hill slopes at night, and the upward currents, dynamically cooled, that blow during the day, together with the generally larger proportion of cloudy sky at the hill stations. On a plateau almost surrounded by hills, or at the bottom of a deep valley between mountain ranges, as at Quetta and Leh, these causes do not act in the same way as on isolated peaks and ridges. Possibly, the large range observed at Katmandu, may also be due to the position of the place in the centre of the valley of Nepal.

On the plains, the daily range is greatest at Jacobabad in Upper Sind, and gradually diminishes towards the east, south-east and north-east; being, on the whole, inversely proportional to the rainfall, or rather to the humidity of the air and the amount of cloud: for, on the sea-coast of Sind and Cutch, the range of temperature is small, although the rainfall is inconsiderable.

In the arid regions of the Trans-Himalaya, the diurnal range is least in winter; and over the greater part of North-Western India, the maximum occurs in the hot weather months, March and April; but at many places in Rajputana and the Punjab, the range in November exceeds that of April. Wherever the winter rains occur with any regularity, two maxima, separated by a secondary minimum in January or February, are observed: but in the Central Provinces and Berar, there is only one maximum. The minimum range of the year, at every station in India, occurs in the middle of the rainy season.

The average range, for any month, does not exceed 34°: and the actual range of a single day, even in Sind, probably never amounts to more than 50°F. The greater ranges, sometimes recorded in Australia and other countries, probably do not represent real variations in the temperature of the air, but are due to the effects of radiation on the thermometers.

In Australia, I understand, there is often a good deal of rivalry between amateur observers, as to which of them can induce the thermometer "in the shade" to mount highest in summer; the shade being sometimes that given by a screen of tin-plate or corrugated iron, little larger than the thermometer it covers.

Calculation of Daily Means.

From Table I, it appears that, at most places, the sunrise temperature or periodic minimum is, on the average of the year, just about as much below the mean of the 24 hours, as the temperature at 4 P.M. is above it; and the differences, in any single month, are usually not great. The arithmetical mean of observations, made at sunrise and 4 P.M., should therefore give a close approximation to the true mean of the day. This combination of hours was adopted by Messrs. VonSchlagintweit, in the meteorological volume of their *Results of a Scientific Mission to India and High Asia.*

The combination of the 4 P.M. temperature with the self-registered minimum, adopted, for many stations, in the annual reports on the meteorology of India, gives results which are too low; the difference being in many cases more than a degree. The mean of the maximum and minimum thermometer readings is usually much too high, especially in the rainy season; but during the long days of May and June, when hot winds blow and the temperature does not vary much between noon and 4 P.M., this combination sometimes gives a result which is less than the true mean of the day.

Of all the combinations that have been adopted in the annual meteorological reports, the best is that of the observations at 4, 10, 16 and 22 hours, though it almost invariably gives a result a little too high. The mean of the minimum, 10 h. and 16 h. observations, is also, with very few exceptions, always too high; but, like the mean of four equidistant observations, it forms a good datum from which to deduce the true mean, by the addition of a negative correction. The method of variable corrections, proportional to the range, (as shown by self-registering instruments) has been described by Mr. Blanford in the *Indian Meteorologist's Vade Mecum*. If this method be adopted, the factors, by which the range is to be multiplied, to get the corrections applicable to the crude mean of each combination of hours, adopted in the annual reports, are those in Table III.

TABLE III-A.—*Range Factors for reducing the means of the Maximum and Minimum observations to true diurnal Means.*

Stations.	Jan.	Feb.	March	April.	May	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Leh	−·07	+·02	·00	·00	−·03	−·03	−·0	−·04	−·02	·00	−·01	−·03
Chakrata	−·15	−·14	−·07	−·06	−·03	−·03	−·07	−·08	−·12	−·10	−·11	−·14
Ranikhet	−·09	−·01	−·03	+·02	−·01	−·02	−·06	−·09	−·09	−·07	−·05	−·05
Lahore	−·06	−·01	−·03	−·01	−·01	−·04	−·06	−·06	−·03	−·05	−·07	−·07
Roorkee	−·01	−·05	−·02	·00	−·01	−·02	−·06	−·08	−·03	−·04	−·05	−·07
Agra	−·04	−·03	−·01	·00	−·01	−·03	+·02	·00	−·01	−·02	−·03	−·02
Lucknow	−·01	·00	+·01	+·02	·00	−·02	−·06	−·06	−·06	−·03	−·02	−·01
Gorakhpur	−·00	−·06	−·02	−·01	−·04	−·03	−·11	−·04	−·05	−·01	−·05	−·05
Allahabad	−·06	−·05	−·02	−·01	−·01	−·00	−·06	−·10	−·10	−·07	−·08	−·09
Patna	−·03	−·02	+·01	·00	−·06	−·09	−·10	−·11	−·09	−·02	−·01	·00
Hazaribagh	−·01	−·03	+·01	·00	·00	−·02	−·04	−·01	−·03	−·01	·00	·00
Kurrachee	−·03	−·06	−·01	−·11	−·18	−·17	−·13	−·20	−·12	−·13	−·10	−·04
Dacca	+·01	+·03	·00	+·04	+·02	−·03	−·02	−·04	−·07	−·03	+·01	+·03
Ajmere	−·05	−·01	−·01	+·02	−·03	−·07	−·10	−·06	−·07	−·04	−·03	−·05
Jeypur	−·06	−·02	−·02	·00	−·03	−·01	−·11	−·11	−·07	−·06	−·03	−·06
Jhansi	−·02	−·03	−·02	−·02	−·01	−·07	−·12	−·08	−·07	−·02	−·01	−·01
Jubbulpore	−·01	−·03	·00	+·01	−·01	−·07	−·11	−·12	−·10	−·05	−·02	−·01
Nagpur	−·04	−·03	+·01	·00	−·03	−·10	−·07	−·01	−·01	+·03	+·02	−·01
Pachmarhi	−·16	−·03	+·06	+·05	−·03	−·05	+·02	−·10	−·10	−·03	+·03	−·02

TABLE III—B.—*Range Factors for reducing the Means of the 16 hours observation and self-registered Minimum to true diurnal Means.*

STATIONS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Leh	+·05	+·10	+·05	+·10	+·05	+·01	−·01	+·02	+·06	+·08	+·07	+·04
Chakrata	+·12	+·06	+·10	+·07	+·08	+·10	+·11	+·11	+·08	+·08	+·08	+·10
Ranikhet	+·05	+·06	+·08	+·11	+·10	+·08	+·07	+·03	+·03	+·02	+·07	+·09
Lahore	−·02	·00	+·01	+·08	+·03	+·02	+·03	+·04	+·01	−·01	−·02	−·02
Roorkee	+·01	·00	+·02	+·04	+·04	+·04	+·03	−·01	+·02	+·01	+·01	+·01
Agra	·00	+·01	·00	+·03	+·04	+·05	+·03	+·10	+·05	·00	·00	+·01
Lucknow	+·03	+·02	+·04	+·06	+·05	+·06	+·00	+·01	+·06	+·02	+·03	+·01
Gorakhpur	−·02	−·01	+·02	+·04	+·02	+·04	+·01	+·09	+·05	+·01	−·01	−·01
Allahabad	−·02	−·01	+·02	+·03	+·04	+·03	+·03	+·03	+·02	·00	−·01	−·02
Patna	·00	+·02	+·03	+·01	·00	·00	+·05	+·03	+·05	+·05	+·05	+·04
Hazaribagh	+·02	·00	+·06	+·06	+·09	+·09	+·10	+·13	+·06	+·05	+·05	+·01
Kurrachee	+·03	+·02	+·08	+·05	+·02	+·01	+·08	·00	+·05	−·04	·00	+·04
Deesa	+·04	+·04	+·04	+·08	+·05	+·04	+·06	+·05	−·01	+·01	+·06	+·06
Ajmere	−·01	+·02	+·04	+·06	+·03	·00	−·01	−·01	+·01	·00	·00	+·01
Jeypur	−·03	+·02	+·02	+·04	+·01	+·01	+·03	+·01	·00	−·01	−·01	−·04
Jhansi	+·03	+·02	+·03	+·03	+·05	+·06	+·02	+·07	+·01	+·04	+·04	+·03
Jubbulpore	−·01	+·01	+·03	+·05	+·03	+·05	+·03	+·01	−·01	·00	+·02	·00
Nagpur	−·01	·00	+·04	+·05	+·04	+·02	+·07	+·08	+·04	+·05	+·05	·00
Pachmarhi	−·04	+·01	+·10	+·06	+·04	+·03	+·10	−·03	+·01	+·02	+·01	+·03

TABLE III—C.—*Range Factors for reducing the Means of the 10 hours, 16 hours, and Minimum observations to true diurnal Means.*

STATIONS.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Leh	−·00	−·03	−·03	·00	−·03	−·04	−·02	−·04	−·03	·00	−·02	−·05
Chakráta	−·08	−·03	−·02	−·05	−·04	−·02	·00	−·01	−·04	−·06	−·06	−·03
Ranikhet	−·02	·00	·00	+·01	·00	−·01	−·00	−·03	−·04	−·05	−·02	+·01
Lahore	−·05	−·04	−·04	−·01	−·04	−·03	−·01	−·02	−·05	−·07	−·08	−·07
Roorkee	−·03	−·04	−·04	−·05	−·04	−·01	−·01	−·00	−·04	−·07	−·07	−·05
Agra	−·02	−·01	−·04	−·02	−·01	·00	+·03	+·04	·00	−·04	−·04	−·02
Lucknow	−·02	−·03	−·03	−·03	−·02	·00	−·02	−·01	−·03	−·06	−·06	−·03
Gorakhpur	−·07	−·07	−·05	−·02	−·02	+·01	−·01	−·01	−·01	−·06	−·06	−·06
Allahabad	−·06	−·06	−·06	−·06	−·03	−·02	−·02	−·04	−·07	−·09	−·09	−·09

TABLE III—C.—*Range Factors for reducing the Means of the 10 hours, 16 hours, and Minimum observations to true diurnal Means*—contd.

STATIONS.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept	Oct.	Nov.	Dec.
Patna	—·08	—·07	—·06	—·04	—·07	—·06	—·03	—·05	—·04	—·07	—·07	—·06
Hazaribagh	—·01	·00	·00	·00	+·02	+·04	+·05	+·05	·00	—·02	—·02	·00
Kurrachee	—·03	—·05	—·02	—·04	—·06	—·00	—·01	—·06	—·05	—·11	—·09	—·03
Deesa	—·02	—·02	—·02	+·02	+·03	+·03	+·04	+·02	—·04	—·08	—·04	—·02
Ajmere	—·08	—·04	—·05	—·04	—·04	—·04	—·05	—·06	—·07	—·11	—·11	—·07
Jeypur	—·10	—·07	—·04	—·02	—·04	·00	—·02	—·03	—·05	—·09	—·13	—·11
Jhansi	—·02	—·03	—·03	—·04	—·01	·00	—·01	—·01	—·06	—·06	—·06	—·04
Jubbulpore	—·04	—·03	—·03	—·02	—·04	—·02	—·01	—·03	—·03	—·08	—·06	—·06
Nagpur	—·05	—·05	—·03	—·02	—·03	—·02	·00	—·01	—·05	—·06	—·04	—·06
Pachmarhi	—·14	—·07	—·01	·00	—·02	+·02	+·06	—·03	—·06	—·11	—·10	—·10

TABLE III—D.—*Range Factors for reducing the Means of observations at 4, 10, 16 and 22 hours to true diurnal Means.*

STATIONS.	Jan	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Leh	—·02	—·02	—·02	·00	·00	·00	·00	·00	·00	·00	—·02	—·03
Lahore	—·03	—·02	—·02	—·01	·00	—·01	·00	—·01	—·02	—·03	—·04	—·03
Roorkee	—·02	—·02	—·02	—·02	—·01	·00	·00	—·03	—·01	—·03	—·03	—·02
Agra	—·05	—·03	—·04	—·03	—·02	—·01	—·01	·00	—·02	—·03	—·04	—·04
Lucknow	—·04	—·03	—·02	—·01	—·01	+·01	—·02	—·01	—·02	—·03	—·03	—·04
Gorakhpur	—·04	—·03	—·03	—·02	—·02	—·01	—·02	—·01	—·03	—·04	—·04	—·05
Allahabad	—·03	—·03	—·03	—·03	—·01	·00	—·01	—·03	—·03	—·04	—·05	—·04
Patna	—·03	—·02	—·02	—·02	—·02	—·01	—·01	—·02	—·02	—·03	—·03	—·02
Hazaribagh	·00	·00	+·01	+·01	+·03	+·02	+·02	·00	+·02	·00	·00	·00
Kurrachee	—·03	—·02	—·03	—·01	—·01	—·02	—·01	—·02	—·02	—·03	—·04	—·04
Deesa	—·02	—·03	—·02	—·01	—·01	·00	—·02	—·01	—·02	—·02	—·03	—·01
Ajmere	—·04	—·02	—·02	—·02	—·03	—·01	—·01	·00	—·02	—·03	—·03	—·03
Jeypur	—·06	—·03	—·03	—·01	—·01	+·01	—·01	—·01	—·01	—·03	—·07	—·06
Jhansi	—·04	—·03	—·03	—·02	—·01	—·01	—·02	—·01	—·02	—·03	—·06	—·04
Jubbulpore	—·03	—·02	—·02	—·01	—·01	·00	·00	·00	—·02	—·03	—·03	—·03
Nagpur	—·02	—·03	—·02	—·01	·00	—·01	—·01	—·01	—·02	—·02	—·03	—·03
Pachmarhi	—·01	—·02	—·01	—·02	—·01	—·02	—·02	—·01	—·02	—·04	—·05	—·04

Monthly and Annual Mean Temperatures.

In the next table, the most probable values of the monthly mean temperatures, at all the regular meteorological observatories, in the region with which this paper deals, and, at many minor stations, are given. The names of the observatories are distinguished by being printed in small capitals. The original registers of all the observatories in the North-Western Provinces and Eastern Rajputana have been gone over and corrected, and the resulting means reduced by means of factors from Table III, or combinations of them. Thus, for Bareilly, the means of the factors for Rurki and Lucknow have been used, and for Benares those of Allahabad. The monthly means for the minor stations have been corrected, as far as possible, in a similar manner.

In the Punjab, prior to 1876, the thermometers, at the observatories, were generally exposed on Glaisher's stands, and the means of the maximum and minimum thermometer readings were taken to represent the daily means. Under these circumstances, the figures published in the annual reports on the meteorology of the Punjab, had no very direct relation to the true mean temperatures; and though they were empirically corrected, before the means in Table IV were struck, the latter must be looked upon as somewhat doubtful in consequence. Another circumstance which renders the mean temperatures of Punjab stations in Table IV a little uncertain is, that hourly observations have been made at only one station in that Province, and the range factors of Lahore probably do not fit Peshawar or Rawal Pindi. These uncertainties, however, probably do not affect the annual mean, to the extent of more than half a degree.

For the hill observatories in the Punjab and Baluchistan, the range factors of Chakráta or Ranikhet have been employed, and for the hill stations in Rajputana and the Central Provinces, those of Pachmarhi. For stations in the Central Provinces and Central India, between 1,000 and 2,000 feet elevation, the factors of Jubbulpore have been used; and for lower stations in these provinces and Berar, the factors of Nagpur. In the Bombay Presidency, the factors of Bombay, Deesa and Kurrachee, or combinations of them, have been employed; except for Jacobabad, for which station the Jeypore factors have been used.

Table IV.—*Monthly Mean Temperatures at places in North-Western India.*

Region	Place	Elevation above sea-level	January	February	March	April	May	June	July.	August.	September.	October	November	December	Year.	Number of years
		Feet.	°	°	°	°	°	°	°	°	°	°	°	°	°	
Himalaya and Western Tibet	Yarkand . .	4,200	29·5	30·9	44·4	61·1	69·4	75·8	81·7	(77·0)	(61·1)*	44·1*	35·0	24·2	52·4	1—2
	Gilgit . .	4,890	39·4	44·9	56·0	63·1	71·9	81·4	81·4	79·3	70·4	60·3	48·1	40·0	61·4	1—3
	Skardo . .	7,700	32·0	39·0	45·0	51·0	58·0	66·0	69·0	68·0	59·0	52·5	43·0	33·0	51·8	1
	Leh . .	11,538	17·0	22·9	32·8	43·5	48·9	56·4	60·6	60·3	53·9	42·3	32·3	24·1	41·3	6—11
	Spiti . .	13,000	19·7	20·4	23·9	29·6	47·9	58·3	61·9	57·3	54·7	41·1	24·9	18·8	39·9	1
	Kanam . .	9,300	28·8	31·6	37·2	46·6	56·7	63·7	66·6	65·0	61·3	54·1	42·6	36·1	49·4	2
	Kardong . .	10,240	24·0	26·0	44·0	47·0	49·0	54·0	63·0	60·0	52·0	46·0	37·0	27·0	44·0	1
	Srinagar . .	5,250	40·0	45·0	70·0	56·0	66·0	70·0	73·0	71·0	63·0	57·0	54·0	42·0	56·8	2

* Interpolated

TABLE IV.—*Monthly Mean Temperatures at places in North-Western India*—contd.

REGION	PLACE	Elevation above Sea-level	January	February	March	April	May	June	July	August	September	October	November	December	Year	Number of years
		feet	°	°	°	°	°	°	°	°	°	°	°	°	°	
HIMALAYA AND W. TIBET—*contd*	MURREE.	6 341	40·3	41·4	50·5	58·1	65·8	72·8	69·6	68·3	67·0	60·5	50·6	44·5	57·5	18—15
	Pangi	8 100	30·5	29·5	36·0	42·5	49·5	62·0	65·5	61·5	62·0	46·0	41·5	36·0	47·1	1
	Dalhousie	6 710	40·7	42·8	52·0	59·0	63·0	65·2	64·1	63·6	62·3	53·2	52·6	45·1	55·0	1—2
	DHARMSALA	4 700	44·6	49·1	57·3	66·3	72·3	75·8	70·7	69·6	69·0	61·6	57·7	50·5	62·5	4—5
	Kangra	2,350	49·7	55·4	62·0	68·4	79·0	85·7	78·2	76·0	75·0	67·0	60·6	53·7	67·6	3
	Kotgarh	6,110	42·4	49·9	54·1	60·5	69·1	71·0	68·5	68·0	66·1	57·7	49·5	46·5	58·0	1—3
	Kanaoli	6 650	39·6	39·6	54·8	54·2	64·2	69·3	67·2	65·9	66·1	61·1	53·6	45·9	56·8	1—3
	Dagshai	6,020	38·0	53·6	58·0	63·4	69·0	74·3	68·6	67·8	66·6	63·6	56·5	46·7	60·6	1—3
	SIMLA	6 953	42·4	44·7	50·5	60·1	65·1	69·6	65·7	64·2	62·2	56·8	50·0	45·3	56·4	17—20
	CHAKRÍTA	7,072	42·3	43·7	50·7	59·0	61·4	67·7	64·3	64·2	63·1	57·8	51·8	46·2	56·3	13—14
	MUSSOORIE (1)	6,910	41·7	44·2	51·7	59·6	65·6	68·5	65·7	64·1	63·0	57·3	52·0	46·0	56·6	3—14
	MUSSOORIE (2)	5 858	45·6	47·0	57·2	63·5	67·0	70·8	69·1	66·3	65·2	63·0	56·6	47·6	59·6	1—3
	Landour	7,500	37·8	41·1	49·1	56·7	62·2	68·5	65·3	63·9	64·2	58·4	49·1	44·1	55·2	4—5
	Kalsi .	1 860	58·3	61·0	62·0	77·7	81·2	86·0	83·7	80·2	77·2	70·8	63·2	59·7	71·3	1—2
	DEHRA	2,220	53·3	58·2	66·1	76·9	82·1	84·7	80·1	78·8	77·6	70·6	62·8	56·1	70·7	18—20
	PAURI	5 103	45·9	50·2	57·5	63·7	69·8	74·3	71·7	69·8	68·5	61·6	54·8	47·7	61·3	1—3 (corrected)
	RANIKHET	6 903	46·3	48·7	56·4	65·5	68·0	71·1	67·9	67·3	66·2	61·2	55·2	49·7	60·3	11—12
	Hawalbagh	4,110	47·0	55·0	61·0	66·0	73·0	75·0	73·0	72·0	75·0	69·0	60·0	52·0	65·9	1
	Almora .	5 510	46·3	52·2	57·4	64·7	70·3	75·0	73·2	72·5	72·5	66·4	57·9	51·2	63·2	6—7
	NAINI TAL	6,460	42·8	45·3	53·5	60·1	66·0	69·1	68·1	67·3	66·4	59·3	52·7	46·6	58·2	10
	Lohughat	5 650	44·5	45·8	52·3	60·9	66·0	71·0	71·1	70·7	68·7	63·1	51·9	46·4	59·4	2—3
	PITHORAGARH	5,374	49·1	48·6	62·2	66·3	67·8	70·1	70·4	70·1	70·4	65·3	57·0	55·1	62·7	1—2
	Nati	11,460							58·6	58·6	55·0	.			?	1
	KATMANDU .	4,351	47·4	50·3	56·6	61·6	67·5	73·1	73·1	73·1	70·7	64·7	55·6	49·5	61·7	10—11
AFGHANISTAN AND BELUCHISTAN	Cabul	6,780	30·1	32·2	42·0	53·5	61·6	71·3							?	1 (corrected)
	QUETTA	5,500	30·3	45·5	53·6	60·1	69·2	74·9	78·4	75·5	67·0	57·9	45·7	41·6	59·0	5—6
	Khelat	7,100	36·6	42·4	49·4	56·6	64·6	70·6	73·3	69·8	60·8	52·1	41·3	39·3	54·6	24—(corrected)
	Mitri .	600	58·4	60·4	74·4		..						61·5	60·0	?	1
SIND	JACOBABAD	180	56·8	62·5	75·1	83·7	92·2	96·1	94·5	90·0	88·6	78·5	64·0	56·5	78·2	4—5
	HYDERABAD	134	63·6	67·7	80·6	86·6	91·4	91·1	89·5	86·5	86·3	83·0	72·0	64·0	80·2	5—7
	KURRACHEE	49	64·2	67·6	75·2	80·5	84·5	86·8	84·8	82·0	81·6	78·7	73·0	67·4	77·2	24—26
	MITTI .	?						92·7	88·3	88·0	86·6	86·5	80·2		?	1—3
CUTCH & GUJARAT	BHUJ	335	67·7	71·5	80·8	85·6	89·2	87·5	84·5	82·2	82·1	80·6	74·0	67·3	79·5	5—6
	RAJPUT	429	63·3	71·0	80·4	86·8	90·7	88·1	84·1	81·2	81·0	81·2	75·3	70·5	79·9	4—5
	Gogo	Near Sea level	67·4	70·6	79·1	84·6	87·7	86·6	82·7	81·3	82·5	82·6	78·2	73·1	78·6	1—3
	DEESA	460	64·4	70·6	78·9	88·4	92·6	91·1	85·9	81·8	81·9	79·5	73·6	68·4	79·7	23—25
	Baroda	120	70·4	70·8	82·4	90·0	92·2	88·1	83·7	82·1	82·2	79·1	70·9	73·0	80·9	9—10
	SURAT	36	70·8	73·2	79·7	84·6	86·0	85·7	82·3	81·2	81·4	81·6	76·7	72·6	79·6	4—5
KHANDESH, BERAR & C. PROV.	MALEGAON	1,430	69·1	73·0	80·8	86·3	87·8	81·1	79·0	78·7	78·6	78·1	72·9	69·3	78·2	4—5
	Dhulia .	1,000	71·0	75·5	82·0	88·5	92·0	87·5	82·0	80·5	80·0	79·6	74·0	71·0	80·3	6—7

TABLE IV.—*Monthly Mean Temperatures at places in North-Western India*—contd.

REGION.	PLACE.	Elevation above Sea-level.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
			°	°	°	°	°	°	°	°	°	°	°	°	°	
KHANDESH, BERAR, & C. PROV. —contd.	KHANDWA	1,021	66·3	71·3	81·2	89·1	92·3	87·6	80·0	79·3	78·7	77·8	71·9	66·2	78·0	6—7
	CHIKALDA	3,650	62·6	66·8	76·6	82·3	82·6	77·7	70·2	68·2	68·6	69·4	65·8	62·4	71·1	4—5
	BULDANA	2,132	63·5	72·0	81·1	86·9	87·4	80·3	76·7	75·6	74·9	76·1	71·7	65·1	76·7	7—8
	AKOLA	930	68·3	73·4	82·5	90·7	93·4	86·2	80·7	79·6	79·1	77·3	71·7	66·9	79·2	8—9
	AMRAOTI	1,213	60·6	74·1	83·1	90·5	92·0	85·2	80·0	78·8	78·3	77·5	72·7	69·6	79·2	8—9
	PACHMARHI	3,504	57·0	62·8	73·0	81·1	84·1	78·9	71·5	69·7	70·5	67·0	60·4	57·2	69·5	9—10
	HOSHANGABAD	1,020	65·5	70·8	80·1	89·4	93·1	88·4	79·0	78·6	79·2	77·1	70·8	66·2	78·3	12—13
	JUBBULPORE	1,351	61·6	66·3	76·1	86·2	91·2	87·9	79·6	78·7	78·6	74·0	66·6	60·8	75·7	15—17
	SEONI	2,030	63·9	69·1	78·1	85·8	88·7	83·9	76·9	76·1	76·0	72·9	67·1	63·1	75·1	10
	NAGPUR	1,025	69·3	73·8	83·0	90·3	94·2	86·8	80·1	80·0	79·6	78·0	72·1	67·4	79·5	12—13
	CHANDA	652	68·3	74·4	83·2	90·8	93·8	87·3	80·9	80·3	79·8	77·6	71·4	66·5	79·5	11—12
	RAIPUR	909	65·8	71·7	80·6	89·2	93·0	86·6	79·8	79·7	79·3	77·0	71·4	66·5	78·0	12—13
	SAMBALPUR	450	66·7	72·3	81·1	90·4	93·0	87·7	81·1	81·1	81·9	79·5	72·6	66·4	79·5	10—11
	Narsingpur	1,300	64·0	69·1	78·0	88·7	92·0	85·6	80·0	78·3	80·2	77·0	69·0	63·0	77·4	8—9
	Bhandara	850	65·0	70·0	78·5	87·2	89·8	87·0	82·6	80·8	82·2	80·7	71·2	67·0	78·8	6—7
	Wardha	800	68·6	74·0	83·7	92·5	94·8	86·2	80·0	79·0	78·9	76·8	72·8	67·3	79·9	4—5
	Balaghat	1,500 (?)	64·6	70·8	80·5	89·8	91·8	86,5	78 0	78·0	79·3	76·2	69·2	65·3	77·5	6—7
	Mandla	1,490	62·5	67·0	76·5	85·6	90·8	86·4	78·3	77·9	77·6	73·4	66·0	61·0	75·1	11—12
	Chhindwara	2,240	63·1	68 8	77·0	85·8	88·3	83·2	76·3	75·4	75·7	71·9	66·1	62·8	74·5	10—11
	Bilaspur	830	61·1	70·0	77·5	87·8	91·7	87·0	80·2	80·4	82·2	76·9	69·6	65·1	77·7	8—10
	Baitul	2,100	63·0	69·0	77·5	86·3	93·5	82·0	75·2	75 3	76·1	74·5	65·2	61·7	74·6	6—7
MALWA, BUNDELKHAND, AND WESTERN BENGAL.	NEEMUCH	1,640	61·2	67·6	76·0	84·8	88·9	85·8	79·0	77·7	78·1	76·7	69·7	63·8	75·8	9—11
	INDORE	1,823	66·2	70·4	77·5	85·3	87·6	81·7	77·3	75·9	76·2	76·8	70·0	66·0	75·9	9—10
	Guna	1,620	61·0	64·0	75·0	85·0	92·0	90·0	80·0	78·0	78·0	75·0	70·0	63·0	76·2	1
	Morar	830	59·7	65·2	76·4	85·0	94·8	93·4	85·5	84·4	83 8	79·0	71·6	62·8	78·1	4
	JHANSI	855	63·0	68·0	78·0	88·0	94·5	92·8	83·0	82·6	82·2	79 0	71·8	63·0	76·0	10—18
	SAUGOR	1,769	60·3	68 4	78·6	86·7	89·5	86·4	78·0	76·0	77·1	75·8	70·4	64·5	76·3	11—12
	NAUGAON	757	60·7	66·2	77·7	87·0	91·2	90·7	81·7	80·7	80·0	78·8	68·6	61·7	78·0	10—12
	Nagod	1,100	61·3	67·0	77·4	86·1	91·2	88·3	82·2	81·5	81·0	76·8	69·3	63·2	77·1	5
	SUTNA	1,040	60·0	66·6	77·4	87·5	91·2	91·0	82·7	81·7	81·0	77·1	68·4	60·8	77·2	5—9
	HAZARIBAGH	2,010	61·5	66·4	75·5	84·0	86·4	82·0	79·2	78·4	78·1	74·5	67·7	61·8	74·7	13—15
	Ranchi	2,170	62·5	68·2	76·5	84·6	85·5	81·4	79·0	79·2	78·7	75·0	67·4	62·7	75·5	12
	Chaibasa	750	64·9	70·1	80·4	87·4	88·5	83·0	84·0	84·2	83·9	80·0	70·7	67·2	78·1	10
GANGETIC PLAINS.	GYA	375	62·9	69·0	78·7	87·8	90·2	88·7	84·2	83·6	83·6	79·6	70·8	64·1	78·6	14—16
	PATNA	170	59·7	65·2	76·4	85·7	87·0	87·5	84·5	84·0	83·0	79·6	69·5	61·6	77·1	10—15
	Muzaffarpur	180	58·2	64·0	73 7	82 3	87·2	86·8	84·5	84·1	84·0	79·2	69·6	61·0	76·3	7—9
	Chapra	200	59·7	67·0	75·4	86·4	89·6	86·1	85·1	84·2	82·8	79·1	68·5	60·0	77·0	3—5
	GHAZIPUR	231	58 9	65·1	76·6	87·3	90·4	91·2	84·6	85·0	84·4	79·0	69·1	59·1	77·6	5—6
	Azamgarh	230	59·8	68·1	78·2	88·8	88·5	89·0	84·5	85·0	84·0	80·0	69·4	61·9	77·9	3—4
	GORAKHPUR	256	59 6	65·1	75·0	85·0	87·7	88·2	81·0	83·7	83·2	78·3	68·6	61·2	76·7	17—20

TABLE IV.—*Monthly Mean Temperature at places in North-Western India*—contd

REGION	PLACE	Elevation above Sea-level	January	February	March	April	May	June	July	August	September	October	November	December	Year	Number of years
		Feet.	°	°	°	°	°	°	°	°	°	°	°	°	°	
GANGETIC PLAINS—contd	Basti	290	59·2	63·5	75·5	82·2	89·2	87·3	81·3	82·5	81·5	78·2	68·5	59·8	76·1	2—3
	Gonda	350	58·9	65·0	75·8	86·5	88·6	88·8	85·6	83·3	82·1	78·3	68·4	60·3	76·7	8
	Fyzabad	330	59·6	66·1	76·2	85·1	90·8	89·5	85·0	84·5	83·3	79·6	69·7	60·7	77·1	5
	Benares	267	59·7	65·6	75·8	84·9	91·3	90·8	85·0	83·8	83·2	77·8	67·4	60·0	77·2	20—23
	Chunar	290	60·1	65·3	77·3	85·6	92·7	89·3	85·7	83·2	81·1	78·2	68·6	60·9	77·1	3
	Allahabad	397	59·6	65·2	77·2	85·5	93·0	91·3	84·9	83·1	82·6	77·2	66·8	59·6	77·2	14—15
	Cawnpore	420	59·2	66·0	76·6	86·0	91·9	92·3	84·9	83·0	81·1	78·5	68·5	60·6	77·8	4—8
	Lucknow	360	59·5	65·6	75·8	87·0	91·3	92·0	86·2	84·1	84·1	78·3	68·1	59·9	77·7	16—17
	Sitapur	440	57·0	62·2	73·7	81·5	88·9	89·2	84·4	83·1	82·5	77·1	66·6	57·9	75·3	4—6
	Dudrilly	468	59·7	64·8	74·8	82·5	87·8	89·3	84·1	83·2	83·0	76·7	64·8	57·3	74·8	15—16
	Futtehgarh	440	58·1	67·2	74·4	84·0	91·0	91·2	85·1	84·0	82·9	77·6	68·1	59·0	76·9	10—11
	Etawah	509	58·4	64·8	74·4	83·3	90·9	92·5	86·1	85·4	84·0	77·8	68·5	59·0	77·3	3—5
	Agra	550	58·3	65·2	75·2	86·5	93·6	94·5	89·8	86·1	83·7	78·5	68·8	60·8	78·1	24—26
	Muttra	580	59·6	65·0	74·0	83·1	88·7	92·4	86·1	85·3	84·8	79·6	70·2	62·0	77·7	4—5
	Aligarh	619	58·6	63·3	74·0	83·9	91·4	93·6	87·2	86·2	84·5	78·4	68·3	60·6	77·6	3—5
	Delhi	718	56·6	62·0	72·0	82·4	89·1	92·6	86·4	84·0	83·4	76·9	66·2	58·7	75·8	11—14
	Meerut	737	56·3	62·1	71·4	81·8	88·8	91·7	85·9	84·7	83·4	76·7	66·5	57·4	75·1	20—22
	Moradabad	649	57·5	61·2	73·5	81·1	86·6	88·8	84·5	83·8	84·0	74·9	65·6	58·1	73·2	4—5
	Bijnor	760	56·0	61·2	71·5	81·3	89·1	89·9	84·1	83·5	82·4	74·4	63·9	57·6	74·6	5
	Roorkee	887	55·7	60·3	68·7	80·7	87·3	90·4	84·0	83·1	82·1	74·2	63·1	56·2	74·0	19
	Saharanpur	900	55·3	58·9	70·5	78·5	86·3	91·2	86·1	85·4	82·1	76·2	64·2	58·8	74·7	6
	Ulwar	1,960	54·9	61·0	73·5	79·0	86·5	89·0	85·0	84·2	82·1	73·3	63·5	55·2	75·0	3—4
	Bikanir	750	58·6	63·9	76·0	84·0	94·1	95·1	91·0	86·6	87·8	82·9	68·5	58·9	79·6	3—5
	Bhurtpur	600	59·2	64·9	76·8	84·3	89·3	92·9	88·2	85·1	84·0	78·7	69·1	61·1	78·0	6—7
	Jeypur	1,431	58·8	62·8	75·3	84·0	89·0	91·1	84·3	84·7	82·0	76·8	67·0	59·2	76·1	12—13
	Sambhar	1,214	55·7	61·1	71·6	84·7	91·1	92·7	85·7	82·8	83·1	77·1	65·2	58·3	76·1	10—12
	Ajmere	1,618	57·5	62·9	73·1	83·1	89·2	88·7	82·1	80·0	81·5	77·2	67·1	60·1	75·3	15—16
RAJPUTANA	Nasirabad	1,460	60·1	64·0	73·1	84·1	91·3	91·2	85·1	84·0	80·5	78·6	69·7	59·5	76·9	6
	Beawar	2,069	56·0	61·6	70·3	84·0	91·6	90·1	83·2	79·8	79·5	74·1	65·7	57·0	74·5	2—4
	Deoli	1,120	61·6	68·2	80·2	86·2	91·4	89·0	80·7	79·2	80·8	76·6	72·5	64·7	77·7	3
	Jhalrapatan	1,200	60·0	68·1	77·7	87·5	91·0	90·6	83·2	81·0	82·4	77·2	69·2	60·0	77·7	4—5
	Kherwara	1,200	61·0	70·6	79·2	88·8	92·7	89·1	82·5	80·0	80·9	78·3	69·0	61·9	78·1	20—22
	Mount Abu	3,945	56·0	61·0	69·1	76·7	79·1	77·1	71·5	68·8	69·2	69·5	61·6	53·9	68·5	15—16
	Erinpura	1,140	55·5	61·9	73·7	81·0	88·0	89·8	81·8	81·1	81·1	75·8	64·3	56·2	75·2	10—14
	Pachbadra	505	59·8	67·0	76·7	89·1	92·5	92·5	89·1	83·0	84·7	80·6	69·0	62·2	78·9	2—3 (corrected)
	Sirsa	642	54·0	60·1	72·0	82·7	89·8	93·0	90·2	88·7	86·2	78·5	64·6	55·8	76·4	
CIS SUTLEJ PLAINS	Rohtak	780	54·7	61·7	69·2	80·4	90·2	91·1	92·2	85·0	84·7	76·3	64·8	56·0	76·2	3—6
	Feerozpur	640	54·5	62·7	71·7	79·0	88·5	93·0	89·1	86·2	86·2	76·0	64·2	57·3	75·8	7—8
	Ludhia	812	52·9	59·2	68·5	79·2	86·2	92·1	87·6	86·3	84·2	77·1	67·0	54·1	74·0	13—16
	Umbala	900	54·5	61·0	69·0	78·4	86·5	91·1	85·8	85·7	84·1	75·0	63·2	56·2	74·3	5—7

Table of IV.—Monthly Mean of Temperature at places in North-Western India—concld.

Region.	Place	Elevation above Sea-level	January	February	March	April	May	June	July	August	September	October	November	December	Year.	Number of years
		Feet	°	°	°	°	°	°	°	°	°	°	°	°	°	
Panjab	Hoshiarpur	1,060	52·0	56·9	65·5	78·5	85·0	90·4	84·7	84·1	83·6	75·1	59·1	53·7	72·4	2—5
	Jullundur	800	53·8	59·1	67·4	76·4	81·5	87·4	86·9	84·4	83·0	75·9	65·6	57·9	73·4	1—4
	Amritsar	780	51·5	57·9	67·6	78·4	86·5	90·6	87·1	86·7	83·5	75·6	62·0	54·0	73·5	3—4
	Lahore	732	52·7	59·2	69·5	80·8	88·2	93·6	89·2	87·2	85·3	76·2	64·5	55·3	75·1	18—21
	Mooltan	420	53·6	58·5	71·1	80·9	89·5	93·9	92·4	90·0	86·6	77·4	66·8	55·8	76·3	12—16
	Dera Ghazi Khan	400	51·4	59·7	68·9	78·6	85·2	93·8	91·3	88·3	86·2	76·7	64·5	55·5	75·0	3—4
	Dera Ismail Khan	573	52·2	56·5	69·4	78·6	87·5	92·8	92·1	90·1	85·9	75·0	61·4	53·5	74·6	13—15
	Shahpur	650	52·8	54·7	65·0	77·9	90·1	95·3	91·6	90·4	88·5	76·6	61·7	55·4	75·3	3—4
	Sialkot	830	51·6	56·3	67·1	78·7	85·7	92·2	87·0	85·2	83·4	74·2	62·5	53·5	73·1	17—19
	Rawal Pindi	1,652	48·7	51·6	62·3	73·3	82·3	88·8	80·9	83·9	79·0	69·6	57·3	49·6	69·5	14—16
	Peshawar	1,110	49·7	52·8	63·2	71·9	81·8	89·4	89·0	87·2	81·5	71·0	58·1	50·4	70·3	5—6
	Thull	2,250	48·9	50·1	62·2	73·6	84·7	89·2	86·0	83·0	79·5	70·9	57·1	49·0	69·5	1 (corrtd).

The mean temperature of Delhi, in this table, is founded on three series of observations, the longest of which, from 1875 to 1881, having been made at the hospital in the city, is considerably too high; while the next longest, extending over parts of 1851, 1852 and 1853 and the whole of 1854, appears, by comparison with surrounding stations, to be too low. The annual means of the three series are :—

1851-54	74·4°
3 years from Sanitary Report	75·6°
1875-81	77·5°
Adopted mean	75·8°

At Simla also, three independent series of observations give results which differ considerably, but this is probably owing to differences of elevation and aspect in the places where the observations were made. The annual means are :—

1841-45	54·6°
1850-56	57·8°
1867-81	56·5°
Adopted mean	56·1°

At several geographically important stations, and at some others, used in computing the rate of vertical decrement, the means, for short periods, have been corrected, by comparison with simultaneous observations, at other stations, similarly situated. Thus, the observations made at Cabul have been corrected by comparison with those of Murree.

At the Trans-Himalayan stations, and in Afghanistan and Beluchistan, that is to say, wherever the influence of the summer monsoon is not felt, the highest temperature of the year is reached in July; as it is in Europe and North America. In the Punjab, Upper Sind, Rajputana and the North-Western Provinces, west of Lucknow, June is the hottest month; while on the Bombay coast and in Malwa, the Central Provinces, Lower Bengal and Behar, where the rains usually set in before the middle of June, the hottest month is May.

Over the greater part of the region here dealt with, the lowest temperature of the normal year occurs in the beginning of January; but, in the Central Provinces, December is normally cooler than January. In these districts, the north-east winds, which usually blow during the cold season, are replaced, for a few days, by warmer south-westerly winds, at times, in January and February, when rain falls in North-Western India; but the precipitation which accompanies these winds in the Central Provinces is not sufficient to lower the temperature appreciably. Accordingly, we find that the lowest temperature is attained in December, when the north-easterly winds are steadiest.

Annual Range of Temperature (Plate XVIII).

From Table IV, it may be seen that the annual range of temperature, as measured by the difference between the mean temperatures of the hottest and coldest months, is greatest at the Trans-Himalayan stations and in Upper Sind and Beluchistan; while it is much less in the Himalaya and at the hill stations in Central India, and least of all on the coast of the Gulf of Cambay. From the meteorological reports of the last four or five years, and other sources, mean values of the absolute range, for several years, at many of the stations in Table IV, have been obtained; and by assuming that, for neighbouring places, the absolute range is proportional to the range of the monthly means, it is possible to arrive at approximate values for the absolute range at nearly all the stations, by a simple application of the Rule of Three. This has been done in drawing up Table V; where the names of stations, at which the absolute range has been found by observation, are printed in small capitals.

Table V.—*Annual Range of Temperature.*

Place	Annual Range		Place	Annual Range	
	Of monthly means	Of extremes.		Of monthly means.	Of extremes
	°	°		°	°
Yarkand*	61·2	100·0	Chakrata	25·4	63·5
Gilgit	42·0	88·2	Mussooree (1)	26·8	67·0
Leh	43·6	91·4	Mussooree (2)	25·2	63·0
Spiti	43·6	91·4	Kalsi	27·7	66·5
Kanâm	37·8	80·0	Dehra	29·4	70·0
Kardong	39·0	89·7	Pauri	28·4	66·5
Srinagar	33·0	75·0	Ranikhet	21·8	58·1
Murree	32·5	70·7	Almora	28·7	67·1
Pangi	36·0	82·8	Naini Tal	26·8	63·1
Dalhousie	21·7	60·3	Lohughat	26·6	63·8
Dharmsala	31·2	73·3	Katmandu	27·7	61·8
Kangra	36·0	85·7	Quetta	39·1	84·5
Kotgarh	28·6	68·0	Kelat	36·7	78·4
Kasauli	20·7	71·6	Jacobabad	39·7	88·4
Simla	27·2	65·6	Hyderabad	27·8	77·7

* One year only

Place.	Annual Range	
	Of monthly means.	Of extremes.
	°	°
Kurrachee	22·6	64·0
Bhuj	21·9	64·5
Rajkot	22·2	71·9
Gogo	19·8	61·4
Dessa	27·2	71·0
Baroda	21·8	56·9
Surat	15·2	47·1
Bombay	11·7	34·5
Malegaon	18·7	70·6
Khandwa	29·1	71·8
Chikalda	20·2	53·0
Buldana	19·3	55·6
Akola	20·5	69·0
Amraoti	23·4	64·2
Pachmarhi	27·1	65·9
Hoshangabad	27·9	72·2
Jubbulpore	30·4	75·9
Seoni	25·0	68·9
Nagpur	26·8	69·4
Chanda	27·3	73·9
Raipur	26·7	66·7
Sambalpur	26·6	68·4
Narsinghpur	29·0	74·0
Bhandara	24·8	64·5
Wardha	26·5	68·9
Bálaghát	27·4	72·6
Mandla	29·2	73·0
Chhindwara	25·5	68·8
Bilaspur	27·0	60·0
Baitul	26·8	67·0
Neemuch	27·7	73·2
Indore	21·6	63·2
Guna	31·0	71·3
Morar	35·1	76·5
Jhansi	32·5	73·7

Place.	Annual Range	
	Of monthly means.	Of extremes.
	°	°
Saugor	20·2	66·8
Nowgong	33·5	77·1
Nagod	29·9	74·7
Sutna	30·4	75·8
Hazaribagh	24·0	63·7
Chaibasa	23·0	60·7
Gya	27·3	70·4
Patna	28·2	69·6
Muzaffarpur	29·0	71·8
Chapra	29·9	73·8
Azamgarh	30·1	72·0
Gorakhpur	28·6	70·3
Basti	29·1	71·0
Gonda	29·0	73·6
Fyzabad	31·2	76·7
Benares	31·6	79·4
Chunar	32·6	75·6
Allahabad	32·4	76·6
Cawnpore	33·1	76·8
Lucknow	32·5	76·9
Sitapur	32·2	75·7
Bareilly	32·6	75·8
Futehgarh	33·1	78·8
Etawah	34·1	76·0
Agra	30·2	76·2
Aligarh	35·0	77·0
Delhi	36·0	79·2
Meerut	35·4	76·6
Moradabad	32·3	75·0
Bijnor	33·9	77·3
Roorkee	24·7	79·2
Saharanpur	35·7	81·4
Ulwar	30·0	77·0
Bickaneer	36·5	75·9
Bhurtpur	33·7	76·0

Place.	Annual Range		Place.	Annual Range	
	Of monthly means	Of extremes		Of monthly means.	Of extremes.
	°	°		°	°
Jeypur	32·3	74·6	Umbala	30·6	82·3
Sambhar	37·1	75·0	Hoshiarpur	38·4	85·6
Ajmere	31·0	75·2	Amritsar	39·1	86·0
Nasirabad	30·0	75·0	Lahore	40·9	86·6
Jhalrapatan	32·1	75·7	Mooltan	40·3	86·2
Kherwara	28·7	74·7	Dehra Ghazi Khan	42·4	90·7
Mount Abu	22·5	68·7	Dehra Ismail Khan	40·6	89·5
Pachbadra	32·6	76·0	Shahpur	42·5	90·1
Sirsa	30·0	83·0	Sialkot	40·0	88·1
Bahawalpur	41·4	88·5	Rawal Pindi	40·1	87·1
Ferozpur	38·5	82·1	Peshawar	40·2	87·8
Ludhiana	39·2	87·5	Thull	40·3	88·0

Other things being equal, the annual range of temperature should increase with the latitude, from a value but little exceeding the daily range at the Equator, to something very great near the poles. In a general way, the figures in Table V conform to this rule; but they also vary, in a remarkable degree, with the distance from the sea; and especially with the rainfall, the variation in this case being inverse. On the last of the maps appended to this paper (Plate XVIII) lines of equal annual range have been drawn. In almost every respect, they follow the lines of equal rainfall, except that they are shifted slightly to the northward; the region of maximum temperature range, in Sind and Beluchistan, lying about two degrees to the north of the region of minimum rainfall. The zones of minimum temperature range, on the coasts of the Konkan and Bengal, in the Himalayas, the Vindhya and Satpura ranges, and at Mount Abu in Rajputana, all coincide with zones of unusually heavy rain. The only exception to the rule, that regions of heavy rainfall have a small temperature range, appears to be the Rewah country, including the Kaimur range, the upper Sone valley, the vicinity of Jubbulpore and the Amarakantak plateau. This region is represented by very few stations; but there is no reason to doubt the reality of the temperature range given by the observations at Jubbulpore. From these it appears that, the large range is due quite as much to the low temperature of the winter months, as to the great heat of May and June; the region being distinctly cooler than surrounding districts, on the average of the year. Possibly, the fact that this part of the country contains a larger proportion of forest area than any other, may have something to do with its coolness in the winter season, though I am not aware of the existence of any other evidence, to show that forest lands are cooler than the open country in winter. In this part of the world, however, though the term winter may be applied to the cool season, it must not be understood in its ordinary sense.

Variations of Long Period.

The question of a variation of temperature, having a period longer than a year, has been much discussed of late, and Dr. W. Köppen, Mr E J. Stone and others have brought forward enough evidence to prove that, in tropical countries at least, the air temperature is very probably subject to a slight variation, the period of which is about eleven years; and which is related inversely to the number of spots seen upon the sun's surface For all the more important stations, included in the previous tables, at which observations for five years or upwards have been made, I have taken the variations, month by month, from the monthly means, and combined the whole of the results for each year. These mean results are shown in Table VI.

Table VI.—*Variations of Long Period*

Year.	January	February	March.	April	May	June	July	August	September	October	November	December	Year	Number of stations
1850	−2·6	−3·5	−1·0	−1·7	+0·8	+1·0	+4·5	+0·2	+0·6	+1·2	+1·0	+1·5	+0·1	1—12
1851	+0·7	−0·4	+0·2	+0·1	+1·1	+0·7	0·0	+0·7	−0·1	+0·7	−0·3	+0·4	+0·3	14—23
1852	−0·5	+2·8	−2·5	−2·1	−3·0	−1·3	−0·8	−1·2	−0·2	+0·2	+1·2	−0·3	−0·6	21—27
1853	−2·0	+1·4	+0·8	−0·6	−0·3	+0·5	−0·8	+1·2	+1·4	+0·1	+1·5	+0·5	+0·6	16—26
1854	+1·7	−1·8	−0·5	+0·2	−0·1	−0·1	0·0	+0·4	−0·1	−0·4	−0·2	+0·2	−0·1	17—27
1855	−2·9	+1·3	−0·1	−3·1	+1·6	+1·4	−1·7	+1·2	−0·5	0·0	−0·1	0·0	−0·5	5—10
1856	+3·1	+1·1	+4·2	+2·1	+1·6	−2·3	−0·2	−0·8	−0·4	+0·2	+0·9	0·0	+0·8	10—14
1857	−0·7	+1·3	+1·4	−2·4	−0·7	−0·5	−0·3	−1·2	−1·7	−0·8	−2·5	−0·6	−0·7	4— 6
1858	−1·1	−0·5	−0·4	+0·3	+0·5	−0·8	−0·5	−0·6	+0·2	−1·2	−0·2	−0·5	−0·4	6— 7
1859	+1·6	+0·9	−1·4	0·0	+0·2	−1·4	+1·1	−1·1	−0·5	−0·5	+0·8	−0·7	−0·1	7— 9
1860	−0·9	+1·0	+1·5	−0·3	+0·6	+1·2	+0·2	+0·3	−0·3	+1·3	−0·7	+0·6	+0·4	4— 5
1861	+0·2	−0·4	−1·2	+0·8	−1·5	−2·0	−1·2	−0·2	−0·3	−0·6	−2·3	−1·0	−0·8	5— 6
1862	−1·7	+1·4	−2·1	−1·1	−0·4	−0·6	−0·2	+0·5	+0·7	−0·4	−0·4	−0·6	−0·4	5— 6
1863	+0·3	−0·1	+0·2	+0·2	+0·9	−1·2	−0·9	−0·4	+0·4	−0·9	−0·8	−0·8	−0·3	7— 9
1864	−1·8	−1·3	−2·3	−1·1	−2·3	−2·0	+0·3	+0·1	+0·7	+0·2	+1·1	+1·6	−0·6	7— 9
1865	+3·2	+0·5	−1·3	−3·2	−0·3	+3·1	+0·8	+1·3	−0·2	+0·2	−0·7	0·0	+0·3	6— 8
1866	+0·2	−1·6	+1·8	−2·3	+0·3	+0·9	+0·9	−0·7	+0·5	+0·9	+1·0	−0·6	+0·1	10—20
1867	+0·6	−2·0	+0·2	−2·0	−1·2	−1·3	+0·2	−0·4	+0·4	−1·3	0·0	−0·6	−0·6	18—23
1868	−1·5	−1·7	−1·0	−1·1	−0·6	−0·7	+2·3	+2·2	+2·2	+1·7	+2·2	+0·0	+0·3	17—25
1869	+1·4	+1·0	−1·4	+1·4	+1·7	+3·2	+0·6	+1·7	−0·1	−1·4	−1·4	+0·4	+0·6	26—31
1870	+0·6	+1·6	−0·7	−1·4	+1·8	−0·7	+0·2	−0·7	−0·6	+1·8	+0·1	−0·5	+0·1	30—35
1871	+0·2	+2·0	+0·7	+0·2	−2·3	−3·5	−0·2	−0·6	−0·2	+1·6	+2·2	+1·3	+0·1	33—38
1872	+0·2	−1·4	+2·7	−0·6	+1·4	+1·4	−0·8	−0·7	−0·8	−0·7	+0·1	+1·2	+0·2	37—39
1873	0·0	+1·6	+0·5	+1·7	−1·8	+2·4	−0·3	−0·3	−0·3	−1·4	0·0	−0·1	+0·2	40—44
1874	−1·0	−1·8	−2·0	+0·7	+1·8	−3·6	−0·4	−1·0	−0·1	+0·3	−1·4	−0·4	−0·0	42—43
1875	−1·2	−1·3	+3·1	+2·4	−0·5	+0·1	−0·4	−1·0	−1·1	−2·0	−0·4	+1·2	−0·1	41—45
1876	+0·8	−0·1	−0·5	−0·2	+1·7	+1·0	−0·5	−0·4	−1·5	−2·2	−0·7	−0·3	−0·2	38—48
1877	−0·1	−3·7	−1·7	−4·3	−2·2	+0·7	+2·5	+3·3	+2·7	−0·3	+3·3	+1·1	+0·1	50—55
1878	−1·6	+1·4	+1·4	−1·6	−3·1	+2·8	+1·1	0·0	+1·2	+2·5	+0·9	−1·3	+0·3	54—55
1879	+1·1	+1·1	+0·4	+1·9	+2·2	−1·6	−0·1	−1·3	−1·1	−1·0	−3·1	−2·4	−0·3	54—55
1880	+1·0	−2·5	+1·8	−3·2	+0·4	+0·7	−1·4	+0·6	−0·8	+1·1	−0·7	−0·6	−0·3	52—54

It is evident, from the column of annual means in this table, that there is no indication whatever of an eleven-year period, or any other, in the temperature anomalies. Nothing, indeed, in connexion with the temperature of India, is more surprising, than the constancy of the annual mean. As regards the north-west of the country, this appears to be chiefly the result of the law mentioned in Vol. I, page 209, that a wet and consequently cool winter is usually followed by a hot and dry summer, and *vice versâ*.

Though the results in Table VI lend no support to Dr. Köppen's conclusion, they cannot be said to controvert it; because the stations, included in the table, lie partly within, but for the most part beyond the Torrid Zone; while the regular variation, discovered by Köppen, was only found at places between the tropics. The results would, moreover, be doubtless more regular, if the registers of the various stations were more nearly equal in length, and if the numbers of stations, contributing to form the averages for the several years, were more nearly equal. For these reasons, the sum of the negative anomalies, during the 32 years, in the table, exceeds the sum of the positive by 2·3°; or to make the positive and negative anomalies nearly equal, the standard from which these variations are counted should be lowered a tenth of a degree.

Vertical Decrement of Temperature and reduction to Sea-level.

In the annual reports on the meteorology of India, it is assumed that, on the plains and plateaux in the interior of the country, the temperature falls 1°F. in 460 feet of ascent, this being the mean rate deduced from a comparison of the observations of Hazaribagh with those of Berhampur, in the Bengal Delta. In the *Indian Meteorologist's Vade-Mecum*, pages 152-157, Mr. Blanford has shown that in most other parts of India the decrease is more rapid, and that it is subject to a well marked annual inequality. The Chutia Nagpur plateau, about Hazaribagh, being probably abnormally hot for its latitude, I have attempted to obtain rates of decrement which will be more generally applicable than that derived from a comparison of Hazaribagh and Berhampur, by comparing stations of unequal elevation in other parts of Northern India. To eliminate, as far as possible, all local horizontal temperature gradients, the observations of the upper station have, in each case, been compared with the mean of several stations around it; these being combined, in such a way, as to make the mean latitude and longitude nearly the same as those of the upper station.

TABLE VII.—*Variation of Temperature with Height in Hindustan*

Groups of Stations		Elevations in feet			Temperature decrement in degrees per 1 000 feet											
Higher	Lower	Higher	Lower	Difference.	Jan	Feb	March	April	May	June	July	August	Sept.	Oct	Nov	Dec	Year
Rawal Pindi	Peshawar, Sialkot	1,652	970	682	2·86	4·38	4 18	3 08	2·13	2·03	2 27	3 37	3 71	4 10	4 10	2 35	3 43
Jeypur, Sambhar, Ajmere	Deesa, Delhi, Pachbadra, Agra, Bickaneer, Jhansi	1,132	623	809	3 46	4 45	2 60	2 97	3 21	2 84	3·71	2 69	2 10	3·21	3 71	3 41	3 18
Hazaribagh	Chatbasa, 2 Gya	2,010	500	1,510	1·39	1 92	2 52	2 45	2 12	3 71	3 25	3 58	3·52	3 64	2·71	2 18	2 75
Seoni	Nagpur, Jubbulpore	2,030	1,188	842	1 31	1·07	1 90	2 85	4 75	4 28	3·44	3 92	3 33	3 68	2 61	1 19	2·86
Mount Abu	Deesa, Erinpura, Pachbadra, Kherwara	3,945	803	3,142	1·37	2·01	2·45	3 32	3 91	4·29	4 49	4 07	4·14	2 90	1 56	1 59	3 05
Chikalda	Khandwa, Amraoti	3,656	1,119	2,537	2 13	2 32	2 17	2 96	3·78	3 47	3 08	4 18	3 90	3 27	2 56	1·97	3 06
Pachmarhi	Hoshangabad, Khandwa, Seoni, Jubbulpore	3,501	1,361	2,113	3 41	3·08	2 52	3 03	3 41	3 78	3 59	3 97	3 55	3 93	4 06	3 22	3·15
Parus Nath*	2 Hazaribagh, Berhampore	4,450	1,362	3,088	2 71	3 09	2 93	2 90	3 50	3 73	3 70	3 57	4·10	3 76	3 25	2 61	3 32
Mean for Plains and Plateaux below 2,500 feet		1,781	820	961	2·26	2 95	2 80	2 81	3 05	3 41	3·17	3 30	3 17	3 73	3 30	2 26	3 04
Mean for Hill Ranges over 2,500 feet		3,389	1,161	2,728	2 40	2 63	2 52	3 18	3 65	3·82	3 94	3·95	3 92	3 46	2 86	2 45	3·22

* A mountain in the Hazaribagh District beyond the limits of the map

On the Rawal Pindi plateau, the temperature differs least from that of the adjacent plains, in the hot weather and in December and January, while the difference is greatest at the beginning and end of the cold weather. There is a similar but less decided variation in the other three of the lower groups: only in these the decrement is least in the cold weather.

The smallness of the decrement, in winter, is doubtless connected with the anti-cyclonic circulation of the air at that season, as has been pointed out by Mr. Blanford in the work above cited: the cause, to which the movement of the air is to be attributed, being the loss of heat by radiation, which occurs over the plains, almost as efficiently as on the hills and plateaux, when the sky is clear and the absolute humidity of the air is low. The relatively lower temperature of the plateaux, at the end of the rains, is no doubt due to the large proportion of vapour still in the air over the plains, which interferes with nocturnal radiation; and the rapid decrease, observed in February, March and April, at Rawal Pindi, and in May and June at Seoni, is perhaps due to the dust with which the lower strata of the air are loaded; this no doubt acting quite as powerfully as water vapour, in retarding the loss of heat by radiation. In the hot weather the effect of this cause at the North Punjab stations is not observed, because Rawal Pindi is then quite as dusty as Peshawar or Sialkot.

On the hill ranges, from 1,000 to 4,000 feet, the annual variation of the rate of decrease is very regular; attaining its maximum in the rainy season and its minimum in December and January.

On the average of the year, the decrement for 1,000 feet is greater at the higher than at the lower elevations, contrary to what is believed to be the rule in the free atmosphere;* but this, no doubt, is due to the upper stations of the hill ranges being, for the most part, on isolated peaks, which offer but little heating surface to the air. The observed temperature, at these places, must therefore approximate to that which would follow from the law of convective equilibrium; whereas, at the lower stations, the temperature is, to a great extent, determined by local heating of the ground. If we assume that the temperatures, at various elevations up to 4,000 feet, on the table-lands and hill ranges of the interior of Northern India, may be expressed by parabolic formulæ, we get the following rates of decrement for each 1,000 feet of ascent:—

TABLE VIII.—*Vertical Decrement of Temperature in Hindustan.*

Elevation.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
0—1,000 feet . .	2·17	3·16	2·98	2·62	2·81	3·19	2·87	2·98	2·98	3·01	3·69	2·20	2·92
1,000—2,000 . . .	2·28	2·90	2·76	2·90	3·25	3·50	3·30	3·46	3·20	3·69	3·28	2·27	3·07
2,000—3,000 . . .	2·40	2·61	2·52	3·18	3·66	3·81	3·93	3·91	3·91	3·47	2·87	2·35	3·22
3,000—4,000 . . .	2·51	2·38	2·30	3·45	4·06	4·12	4·55	4·42	4·62	3·25	2·46	2·42	3·37

For the reduction of temperatures, at stations in the North-West Himalaya, to sea-level, the formulæ given at Vol. I, page 389, may be employed. These were computed from the observations of Roorkee, Dehra, Chakrata and Leh, on the assumption that the

* See Mr. Glaisher's balloon observations in the British Association Report for 1864.

variation in latitude, between these stations, was uniform, and that the vertical temperature curve for each month approximated to a parabola Since, however, the differences of latitude and elevation, among the four stations selected, are in the same direction and nearly proportional to each other, it is possible that the parts of the temperature variation, dependent upon latitude and elevation respectively, have not been separated in the formulæ, so completely as is desirable, I have therefore attempted to work out values for the decrement with elevation, among the mountains, by a method similar to that now adopted in determining the variation on the plains and table-lands of India.

The following groups of pairs of stations give mean latitudes for the lower and the higher station which do not differ by more than a few miles; and, though the differences of longitude are considerably greater, this does not much matter since the variation of temperature in longitude, is in every month, small —

GROUP I.

Lower Station.	*Higher Station*		Mean *Lat*	Mean *Long*	Mean *Elevn*
			° ′	° ′	feet.
Sialkot	Rawal Pindi				
Sialkot	Dharmsála				
Kángra	Dharmsala	Higher	31 31	76 48	3,250
Hoshiarpur	Kángra	Lower	31 28	76 11	1,950
Hoshiarpur	Dehra				
Dehra	Pauri	Difference	0 3	0 37	1,900
Roorkee	Dehra				
		Mean elevation of group			2,300.

GROUP II

Lower Station.	*Higher Station*		Mean *Lat*	Mean *Long*	Mean *Elevn*
			° ′	° ′	feet
Gilgit	Skardo				
Srinagar	Skardo				
Srinagar	Murree				
Rawal Pindi	Murree				
Dharmsála	Dalhousie	Higher	32 9	76 37	6,730
Dharmsála	Simla	Lower	32 12	76 35	4,420
Dehra	Mussooree (Upper)				
Pauri	Mussooree do	Difference	0 3	0 2	2,310
Pauri	Ranikhet				
Almora	Naini Tal	Mean elevation of group			5,575

GROUP III

Lower Station	*Higher Station.*		Mean *Lat*	Mean *Long*	Mean *Elevn.*
			° ′	° ′	feet.
Skardo	Leh				
Pángi	Leh				
Leh	Spiti	Higher	32 47	77 40	11,060
Kánam	Spiti	Lower	32 33	77 22	8,550
Kánam	Leh				
Chakráta	Kánam	Difference	0 14	0 27	2,510
Chakráta	Landour				
		Mean elevation of group			9,805

From these groups we get the following mean rates of decrement per 1,000 feet of ascent:—

TABLE IX.

Group.	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
	°	°	°	°	°	°	°	°	°	°	°	°	°
I . .	1·79	2·11	2·42	3·47	3·79	4·26	3·63	3·79	4·69	3·16	1·47	1·21	2·98
II	2·18	2·83	2·73	3·05	3·01	3·51	3·39	3·13	2·86	2·43	2·20	1·89	2·77
III .	3·67	3·38	3·27	2·11	2·03	1·67	1·12	1·55	1·61	2·55	3·75	3·90	2·54

According to these results, the rate of decrease of temperature, on the average of the year, diminishes slowly as the height increases; in the same way, but probably not to the same extent as in the free atmosphere. The mean rate, from the lowest to the highest stations, is 2·764° per 1,000 feet or one degree in 362 feet, which is identical with the rate found at Vol. I, page 388. The monthly mean rates, for each group, are subject to a well marked annual variation, the range of which is greatest at the lowest and highest stations, though nearly opposite in phase in these two groups; while, in the intermediate group, it is similar in phase to that of the lower group, though considerably less in range. If the minor inequalities, which are probably, in great part, due to the insufficient length of the registers at several of the stations, be reduced by a process of smoothing, the annual variation becomes more regular. In the following table, the means of the rate for each month and half the sum for the preceding and succeeding months are given.—

TABLE X

Group	Jan	Feb	March.	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
	°	°	°	°	°	°	°	°	°	°	°	°	°
I	1·72	2·11	2·60	3·29	3·63	3·93	3·83	3·97	4·08	3·12	1·83	1·42	2·98
II	2·27	2·61	2·83	2·90	3·15	3·35	3·36	3·13	2·82	2·18	2·16	2·01	2·77
III .	3·60	3·42	3·01	2·38	1·90	1·62	1·36	1·43	1·78	2·59	3·40	3·81	2·54

From these numbers, the following decrements for each 1,000 feet up to 12,000 have been computed, on the assumption that the temperatures, at each 1,000 feet of elevation, in any month, form a series of which the third order of differences is constant:—

TABLE XI.—*Vertical Decrement of Temperature in the Himalaya.*

Height	Jan	Feb.	March	April	May	June	July	Aug	Sept	Oct.	Nov	Dec.	Year
	°	°	°	°	°	°	°	°	°	°	°	°	°
0—1,000 feet .	1·61	1·85	2·44	3·42	4·11	4·00	3·60	4·26	4·94	3·74	1·88	1·35	3·12
1,000—2,000 „ .	1·65	1·99	2·53	3·36	3·96	4·01	3·80	4·11	4·45	3·37	1·83	1·37	3·04
2,000—3,000 „ .	1·74	2·14	2·61	3·29	3·79	3·96	3·85	3·93	3·99	3·06	1·83	1·41	2·97
3,000—4,000 „ .	1·87	2·29	2·69	3·21	3·61	3·62	3·77	3·71	3·57	2·81	1·80	1·58	2·90

TABLE XI.—*Vertical decrement of Temperature in the Himalaya—contd.*

Height.	Jan.	Feb.	March	April	May	June	July	Aug	Sept.	Oct	Nov	Dec	Year
	°	°	°	°	°	°	°	°	°	°	°	°	°
4,000—5,000 feet	2·03	2·45	2·76	3·12	3·40	3·63	3·62	3·45	3·19	2·92	2·00	1·77	2·84
5,000—6,000 „	2·24	2·62	2·89	3·02	3·17	3·37	3·39	3·15	2·81	2·49	2·10	2·03	2·77
6,000—7,000 „	2·49	2·79	2·88	2·91	2·92	3·00	3·05	2·81	2·53	2·41	2·30	2·34	2·71
7,000—8,000 „	2·79	2·97	2·93	2·79	2·55	2·69	2·64	2·44	2·25	2·40	2·67	2·72	2·66
8,000—9,000 „	3·13	3·16	2·97	2·56	2·37	2·27	2·14	2·03	2·01	2·44	3·01	3·15	2·60
9,000—10,000 „	3·50	3·35	3·00	2·42	2·06	1·79	1·56	1·58	1·61	2·54	3·40	3·65	2·56
10,000—11,000 „	3·92	3·55	3·02	2·27	1·73	1·25	0·89	1·09	1·64	2·71	3·84	4·21	2·51
11,000—12,000 „	4·38	3·75	3·04	2·11	1·38	0·65	0·13	0·66	1·51	2·93	4·33	4·82	2·47

By summing these up and interpolating for any fraction of a thousand feet, we get the quantities to be added to the observed temperatures at hill stations, to reduce them to sea-level. These quantities should probably vary somewhat with geographical position, having different values in the dry regions of the North-West and in the moister regions of the Eastern Himalaya; but there will be no great error in considering them constant, for as much of the mountain zone as comes *within the scope of this* paper; especially, as the sea-level value of the air temperature is, under the given conditions, a purely fictitious quantity, corresponding to nothing which actually exists in nature.

SEA-LEVEL TEMPERATURE AND ISOTHERMAL LINES (PLATES XIV TO XVII.)

By means of the rates of decrement, given in Tables VIII and XI, the monthly and annual mean temperatures, in Table IV, have been reduced to sea-level values, and the results are shown in Table XII.

At the end of the table are found interpolated values of the sea-level temperature, for a few points in Afghanistan and Tibet, inserted for the purpose of showing the general direction of the isotherms, in regions beyond the boundary of the map. These values are the means of those given by parabolic interpolation, along the meridians and along the parallels respectively.

The temperature registers of many places in the Himalaya, being for very short periods, the monthly means are subject to a good deal of doubt; and even the *annual means of some stations are probably a* degree or more in error. In the table, therefore, while the temperatures of the regular observatories have been treated independently, the other stations have in many cases been grouped together: and in drawing the charts, the mean sea-level temperature of any group of stations has been assigned to a *point lying* in the centre of the group. The stations on the plains have all been treated independently, as regards Table XII, but, in drawing the charts, I have not hesitated occasionally to

disregard the figures for stations of the third order where these seemed abnormally high or low, in comparison with other places in the vicinity.

TABLE XII.—*Monthly and Annual Mean Temperatures reduced to Sea-level.*

Station.	Jan	Feb	March.	April.	May.	June	July.	August	Sept.	Oct	Nov.	Dec.	Year
	°	°	°	°	°	°	°	°	°	°	°	°	°
Yarkand	27 8	39 7	55·2	78·0	85 5	92 4	97 5	94·6	78 7	57 6	42·8	30 3	65·0
Gilgit	48·7	55·7	66 1	76·0	84·9	95·3	95 5	94·7	86 9	74·3	60·6	48·5	73 9
Srinagar													
Skardo	47·6	55·9	64·5	74·0	83·6	92 5	94·8	94·1	85·1	73 6	57·6	45·6	73·6
Leh	46·3	54 1	65 1	77 0	83 4	90·7	93·0	93·2	87·9	74 1	61·6	52·2	73·3
Spiti	51·7	59 3	65 3	76 4	84·5	91 9	95·4	92 7	88·9	77 5	61·7	53 8	74 8
Kanam													
Kardong													
Murree	52 3	55·7	67 3	78·5	88 8	96·7	92·7	91·9	91·5	79·4	63 0	54·8	76·0
Pangi	50 3	58 0	67·1	74 2	80 5	89·6	94·5	92 8	88 0	73·6	63 4	53·1	73 8
Kardong													
Dalhousie	53·4	59 2	69 3	80·2	88·0	93 3	88 4	87·3	87·1	77·8	65·8	56·9	75 6
Dharmsála													
Kangra													
Kotgarh	52·4	62·1	72·5	79·9	90·5	95·5	91·3	90·9	90·3	79·8	65 6	56·7	77 3
Kasauli													
Dugshai													
Simla	55·9	60·7	69·1	82·3	90·2	95·4	90·7	89·5	87 6	77·2	63 9	57·0	76 6
Chakráta	56 1	60·0	69 6	82 4	89 5	93·8	89·6	89·7	88·7	78·4	65·9	58 2	76·8
Mussooree (1)	54·8	60 6	70·8	81·4	89·6	94·5	89·9	89·2	89 1	78·8	66 1	57 2	76·8
Mussooree (2)													
Landour													
Kalsi	61·2	64·4	67 1	83·8	88 6	93·3	90·4	87 7	85 7	77 2	66 5	62 1	77·3
Debra	59·0	62 7	71·9	88·4	91 0	93 7	88 5	88 1	86 9	77·4	66 3	59·2	77·3
Pauri	55 0	61·2	70 8	80·4	89 0	94·2	90·7	89 7	88 9	77·4	64·5	55·4	76 4
Ranikhet	57 6	62 2	72·4	84 6	10·2	94 2	90 2	90 1	89 3	79 5	67·0	59·4	78·1
Almora	55·3	63 9	71 7	81·1	89 9	94·3	93 5	94 5	93·2	82 4	68·1	58·9	78 9
Hawalbagh													
Naini Tal	55 1	59 9	72 7	81 2	89·4	93·4	91·9	91 2	89 5	78 5	65·4	57·2	77 1
Lohughat	56·8	59 2	71·7	81·5	87 4	91·7	91 2	91·4	91·4	81·2	65·0	59·2	77·3
Pithoragarh													

TABLE XII.—*Monthly and Annual Mean Temperatures reduced to Sea-level*—contd

STATION	Jan	Feb	March	April	May	June	July	August	Sept.	Oct	Nov	Dec	Year
	°	°	°	°	°	°	°	°	°	°	°	°	°
Mitu							90·4	90·8	88·0				
Katmandu	53·0	59·5	67·9	76·0	84·2	89·3	80·5	90·3	88·8	78·6	63·8	56·9	74·8
Cabul	43·5	47·7	60·1	75·2	86·9	96·6							
Thull	51·6	54·5	67·8	81·2	93·7	98·3	94·4	92·4	89·9	78·8	61·3	52·1	76·9
Quetta	42·3	47·5	64·7	78·0	89·6	95·1	98·8	96·5	89·5	74·9	56·2	50·1	76·1
Kelat	50·7	59·0	68·6	79·4	90·0	96·4	98·9	94·6	86·0	73·0	55·6	51·6	75·4
Mitri	50·5	62·0	75·9								66·3	61·1	?
Jacobabad	57·2	63·0	76·0	84·2	92·7	96·7	95·0	91·4	88·5	79·2	64·7	59·8	76·8
Hyderabad	63·9	68·2	81·1	87·0	91·8	91·6	89·9	86·8	86·7	83·7	72·6	64·6	80·7
Kurrachee	64·3	67·8	75·4	80·6	84·6	87·0	84·9	82·1	81·7	78·9	73·2	67·5	77·8
Mitti						92·7	88·8	88·0	86·6	86·5	80·2		
Bhuj	66·6	72·6	82·0	86·7	90·3	88·8	85·4	83·4	83·1	82·3	76·8	66·1	80·6
Rajkot	69·3	75·3	81·7	88·0	91·8	89·5	85·2	82·5	82·1	82·8	76·8	71·4	81·2
Gogo	67·9	70·6	79·1	84·6	87·7	86·6	82·7	81·3	82·5	82·6	78·2	73·4	79·8
Deesa	66·4	72·1	80·2	89·6	93·9	92·6	86·2	83·2	82·2	81·3	75·2	69·4	81·0
Baroda	70·6	71·1	82·7	90·3	93·5	88·4	84·0	82·4	82·5	79·8	77·3	73·2	81·2
Surat	70·9	73·4	79·9	84·7	86·1	85·9	82·4	81·3	81·5	81·2	76·9	72·7	79·7
Malegaon	72·3	77·5	85·0	90·3	92·2	88·8	84·0	83·2	82·7	81·6	77·0	72·5	82·1
Dhulia	73·2	78·7	85·0	91·1	94·3	90·7	84·7	83·5	82·7	83·5	77·7	73·2	83·2
Khandwa	68·5	74·6	84·3	91·8	95·1	91·0	83·4	82·4	81·4	81·0	75·7	68·4	81·5
Chikalda	71·1	77·1	86·4	93·3	95·0	90·9	83·1	81·5	81·5	82·6	77·3	70·8	82·5
Buldana	73·3	70·1	87·2	92·8	94·0	88·0	83·2	82·5	81·4	84·1	79·1	72·9	83·1
Akola	70·4	76·4	85·9	93·1	96·0	89·2	83·1	82·4	81·5	80·8	75·4	69·0	81·9
Amraoti	72·8	76·0	86·7	93·7	95·5	89·1	83·4	82·0	81·7	82·1	77·1	71·3	82·6
Pachmarhi	65·1	72·7	83·0	91·5	95·9	91·4	83·7	82·3	82·5	79·7	71·5	65·2	80·4
Hoshangabad	67·7	74·1	83·2	92·1	96·2	91·7	82·4	81·7	81·9	81·1	74·6	68·4	81·3
Jubbulpore	64·6	70·5	80·9	89·9	95·1	92·4	83·4	83·0	82·4	79·2	71·4	65·8	79·7
Seoni	68·5	75·3	83·9	91·4	94·9	90·6	83·0	82·6	82·1	80·6	74·2	67·8	81·2
Nagpur	70·5	77·1	86·1	93·0	97·0	90·1	82·9	83·1	82·3	82·0	75·9	69·6	82·5
Chanda	69·7	76·4	86·2	92·6	95·6	89·3	82·6	82·2	81·5	80·1	73·8	67·9	81·4
Raipur	69·9	74·7	83·5	91·7	95·6	89·7	82·3	82·6	82·4	81·5	74·9	68·3	81·3
Sambalpur	67·7	73·8	82·4	91·6	94·3	89·1	82·3	82·5	83·0	81·3	74·2	67·4	80·9
Narsinghpur	67·8	73·1	81·8	92·2	95·7	92·9	83·6	82·4	83·9	82·0	73·5	66·9	81·2
Bhandara	66·9	72·7	84·1	89·4	92·3	90·6	81·8	83·3	81·4	84·0	77·2	68·8	81·3

TABLE XII.—*Monthly and Annual Mean Temperatures reduced to Sea-level*—contd.

Station	Jan	Feb	March	April	May	June	July	August	Sept.	Oct	Nov	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Wardha	70·4	76·6	86·1	94·6	97·0	88·8	83·0	81·4	81·0	82·9	75·6	69·0	82·2
Balaghat	67·9	75·5	84·9	91·8	96·2	91·4	82·4	82·7	83·6	81·9	74·5	68·6	81·9
Mandla	65·8	71·7	80·9	89·6	95·2	91·3	83·2	82·6	81·9	79·1	72·2	64·9	79·9
Chhindwara	68·1	73·7	83·6	91·7	95·4	90·9	83·1	82·8	82·7	80·1	74·0	67·8	81·1
Bilaspur	66·1	72·9	80·2	90·1	94·2	89·9	82·5	83·1	81·5	80·2	72·8	67·3	80·3
Betul	68·8	75·8	83·9	92·5	95·4	89·5	82·0	82·5	82·9	82·8	73·8	66·6	81·3
Neemuch	64·9	72·0	80·8	89·3	91·8	91·2	81·8	83·1	82·9	83·0	75·5	67·5	80·7
Indore	70·2	75·9	82·7	90·2	93·1	87·8	82·6	81·8	81·6	82·5	76·3	70·0	81·3
Guna	64·6	69·9	79·7	89·4	90·8	93·3	84·7	83·3	83·7	81·2	78·7	66·6	81·1
Morar	64·5	67·8	77·8	87·1	97·1	90·0	87·7	80·6	80·0	82·2	74·7	64·6	80·8
Jhansi	63·0	70·7	80·5	90·2	90·9	95·5	80·1	85·1	84·5	83·2	75·0	65·8	81·5
Saugor	67·2	73·9	83·8	91·6	94·9	92·3	83·3	82·3	82·1	82·6	76·7	68·5	81·6
Nowgong	62·4	71·6	80·0	89·0	96·1	96·1	86·7	86·0	85·0	84·8	71·4	63·4	80·9
Nagod	63·8	70·5	80·7	89·0	94·4	91·6	85·2	84·8	84·0	84·1	73·3	65·7	80·9
Sohna	63·2	69·9	80·5	90·2	94·2	91·9	85·5	84·8	83·8	81·2	72·2	63·1	80·3
Hazaribagh	66·0	72·5	81·2	89·5	92·5	89·6	81·2	84·8	84·1	82·1	74·7	66·3	80·7
Ranchi	67·3	74·8	82·7	90·6	92·2	91·7	80·5	86·2	85·3	84·0	74·9	67·5	82·0
Chaibasa	66·5	72·5	82·6	89·4	90·6	89·4	86·0	86·4	84·9	83·8	76·4	68·8	81·4
Cuttack	70·9	75·1	82·0	87·0	88·5	86·3	84·6	84·2	83·0	81·0	74·6	69·9	80·4
Gya	68·7	70·1	79·8	88·0	91·3	89·0	85·1	84·7	84·5	81·0	72·1	64·9	79·7
Patna	69·1	68·8	77·0	86·2	88·1	86·1	85·0	84·5	84·1	80·3	70·2	62·0	77·7
Darbhanga	69·8	64·4	74·2	83·8	86·7	85·3	84·1	83·6	84·6	79·5	71·4	62·5	76·6
Muzaffarpur	68·6	65·1	74·3	82·9	87·8	87·3	85·0	84·0	84·5	79·9	70·1	61·5	76·9
Chapra	69·1	67·6	76·0	85·0	90·2	86·7	85·6	84·8	84·3	79·9	69·3	60·4	77·6
Ghazipur	70·1	67·8	77·3	87·0	91·1	92·0	85·2	85·7	85·0	79·9	69·0	59·0	78·2
Azamgarh	69·3	68·0	78·9	86·5	89·2	90·7	85·2	85·7	84·7	81·0	70·3	61·9	78·6
Gorakhpur	69·1	69·9	78·7	86·7	88·1	89·0	84·7	84·1	84·0	79·3	69·7	61·8	77·4
Basti	69·3	66·5	76·1	85·0	87·1	88·3	85·1	83·1	82·3	79·4	69·6	60·5	77·1
Gonda	69·6	66·1	76·8	87·4	89·6	89·9	84·6	84·0	83·9	79·6	69·7	61·0	77·9
Fyzabad	69·3	67·2	77·2	86·9	91·8	90·6	85·9	85·5	84·2	80·9	70·6	61·6	78·1
Benares	69·2	66·5	76·6	86·7	92·1	91·7	85·8	84·6	84·0	78·9	68·1	60·6	78·0
Chunar	69·7	66·3	78·1	86·4	91·5	90·3	84·5	83·1	82·2	79·2	69·0	61·6	78·0
Allahabad	69·3	66·2	78·1	87·5	92·9	92·3	85·7	84·3	83·4	78·4	67·9	60·3	78·1
Cawnpore	69·1	67·4	77·8	87·1	91·1	93·6	86·0	86·2	85·1	80·3	70·0	61·6	79·0

Table XII.—Monthly and Annual Mean Temperatures reduced to Sea level—continued

Station	Jan.	Feb	March.	April	May	June	July	August.	Sept.	Oct.	Nov	Dec	Year
	°	°	°	°	°	°	°	°	°	°	°	°	°
Lucknow	60·3	66·8	76·0	88·0	92·4	93·2	87·2	86·3	85·1	79·7	69·5	60·7	78·8
Sitapur	58·0	63·7	74·0	82·7	90·2	90·0	85·6	84·6	83·6	76·7	68·2	58·9	76·7
Bareilly	57·9	63·6	73·5	84·0	89·4	91·1	85·6	84·9	83·5	77·9	66·9	58·6	76·5
Futehgarh	59·1	63·7	75·7	85·2	92·3	92·6	86·3	85·3	84·0	79·3	69·7	60·5	78·3
Etawah	59·5	66·4	76·9	81·6	92·9	94·1	87·6	86·9	85·3	79·7	70·3	60·1	78·8
Agra	59·5	66·9	76·8	87·9	90·2	96·3	88·3	86·7	85·2	80·7	70·8	62·0	79·7
Muttra	60·9	67·4	76·8	85·0	90·4	94·3	88·0	87·1	86·4	81·9	72·4	63·4	79·5
Aligarh	59·9	65·2	76·8	85·5	93·1	95·5	88·8	88·1	86·0	8·07	70·5	61·9	79·3
Delhi	58·1	64·2	74·1	84·2	91·1	94·8	88·2	86·1	85·2	79·7	68·8	60·2	77·9
Meerut	57·9	64·4	73·6	83·7	90·9	94·0	87·8	86·9	85·8	78·6	68·2	59·0	77·6
Moradabad	58·9	63·2	75·5	83·2	90·4	91·8	86·2	85·7	85·7	77·4	68·0	59·5	77·2
Bijnor	57·7	63·6	73·8	83·8	91·3	92·3	86·1	86·7	84·4	77·3	66·6	59·2	76·5
Roorkee	57·7	63·1	71·3	83·0	89·8	93·2	87·3	86·0	84·8	77·7	66·7	58·2	76·6
Saharanpur	57·6	61·8	73·2	80·9	88·9	94·1	88·6	86·1	84·6	79·3	66·6	60·9	77·4
Ulwar	59·2	63·9	79·1	84·4	95·7	97·4	91·4	90·4	87·9	80·5	75·3	59·6	80·9
Bickaneer	60·3	65·4	80·3	91·0	99·3	97·5	93·0	88·9	89·8	85·9	71·3	60·6	81·7
Bhurtpore	60·5	67·8	78·6	85·9	91·0	94·8	89·8	87·2	85·5	81·0	71·6	62·4	79·9
Jeypore	61·9	67·2	79·6	86·9	91·1	95·8	88·1	85·2	86·6	82·8	72·9	63·4	80·6
Sambhar	63·2	65·3	78·5	89·0	96·0	96·7	89·2	86·6	86·6	82·3	69·7	61·1	79·8
Ajmere	61·1	67·8	78·1	87·8	94·0	94·0	87·1	85·9	86·1	83·4	72·8	63·7	80·1
Nasirabad	63·6	65·5	77·5	88	95·6	96·0	89·6	86·3	84·7	84·2	75·1	62·8	80·9
Beawar	59·5	69·0	76·6	90·4	97·7	96·8	89·2	86·2	85·5	82·0	72·7	61·5	80·5
Deoli	64·1	71·8	83·6	89·2	91·4	93·2	88·8	82·7	83·9	80·9	76·6	63·2	80·7
Jhalrapatan	63·6	72·2	81·4	90·8	96·9	94·7	86·7	84·8	85·9	82·1	72·7	65·3	81·4
Kherwara	66·5	73·8	82·8	92·0	96·8	93·1	85·9	83·7	84·3	83·1	74·9	67·9	82·0
Mount Abu	63·2	72·0	79·9	87·7	93·1	91·6	85·8	83·5	83·7	79·6	69·0	61·0	81·0
Erinpura	58·1	65·6	77·2	87·1	92·1	93·6	88·0	85·0	84·6	80·2	69·6	62·8	78·6
Pachbudra	60·7	68·3	77·9	89·1	93·6	93·7	90·4	84·2	86·7	82·1	70·4	63·0	80·1
Sirsa	56·3	62·4	74·0	84·8	91·8	96·0	91·9	90·7	87·9	81·1	67·1	57·2	78·4
Bhawalpur	55·0	62·9	70·3	81·4	91·3	97·3	93·2	89·1	85·7	77·7	66·2	57·1	77·3
Ferozepore	55·9	64·7	73·5	80·8	90·3	95·0	90·8	88·1	87·9	78·5	67·6	58·7	77·8
Ludhiana	54·7	60·7	70·9	81·3	88·5	94·7	89·7	88·7	86·4	78·1	66·0	56·2	76·8
Umbala	56·5	63·8	72·5	80·7	89·0	93·0	88·2	88·3	86·7	78·5	66·5	58·2	76·9
Hoshiarpur	54·4	60·3	68·7	81·3	88·1	93·8	87·6	87·3	86·0	79·3	68·0	55·5	75·4

Table XII.—Monthly and Annual Mean Temperatures reduced to Sea-level—concluded.

Station	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct	Nov	Dec	Year
	°	°	°	°	°	°	°	°	°	°	°	°	°
Jullundur	55·6	61·7	67·8	78·5	83·6	90·0	89·0	86·8	80·1	70·1	63·6	59·7	75·8
Amritsar	53·3	60·1	70·0	80·5	88·8	91·1	89·5	86·1	85·6	78·7	64·9	55·8	75·8
Lahore	54·3	61·5	71·8	82·7	90·5	95·0	91·1	89·4	87·2	79·1	67·2	56·0	77·3
Mooltan	54·5	59·9	72·1	82·0	90·7	94·2	93·5	91·2	87·0	79·0	67·3	56·2	77·5
Dera Ghazi Khan	52·3	61·0	70·1	79·7	86·3	95·1	92·3	89·5	87·2	78·2	65·0	56·3	76·3
Dera Ismail Khan	55·4	58·3	71·1	80·1	87·1	94·6	93·6	91·8	87·4	77·2	63·5	54·8	76·3
Shahpur	54·9	60·7	71·0	79·7	91·9	97·3	95·3	92·3	90·2	79·1	67·1	56·8	77·3
Kohat	47·4	56·9	67·5	80·8	85·0	94·8	87·2	85·0	85·0	77·1	63·6	55·3	75·5
Multan	54·4	61·7	69·0	79·2	87·5	95·0	93·3	87·5	87·1	78·7	68·0	56·6	77·2
Peshawar	52·4	56·8	67·1	77·7	87·2	94·2	91·7	89·2	84·7	75·9	63·1	53·3	74·4
Peshawar	52·2	57·3	66·5	78·1	85·0	92·0	92·9	87·5	84·5	75·3	62·1	52·9	73·8

Interpolated values.

Meridian of 68° E.	Lat. 32	41·2	52·5	69·3	79·2	87·3	96·3	94·5	87·2	81·5	72·7	59·7	46·8	73·5
	„ 34	43·0	47·0	73·1	77·7	84·6	95·6	100·0	100·0	87·4	71·0	57·5	44·1	71·7
	„ 36	37·5	41·5	56·0	73·2	81·9	91·5	101·5	98·8	84·0	68·2	53·0	39·5	70·0
Met. Lat. of 30° E.	Lat. 32	40·0	50·5	61·5	74·0	87·5	91·5	94·5	93·0	87·5	76·7	60·6	49·5	73·1
	„ 34	45·5	50·4	61·7	72·7	83·0	94·0	97·2	94·7	85·9	75·0	59·2	46·5	71·1
	„ 36	42·0	48·2	57·7	71·4	83·0	91·5	99·9	95·0	83·5	69·7	56·6	44·5	68·4
Meridian of 84° E.	Lat. 32	41·5	53·4	64·0	74·7	87·5	87·8	94·6	92·8	86·0	75·0	61·5	50·0	72·5
	„ 34	45·3	47·8	61·5	73·4	83·7	87·2	100·3	95·5	84·1	73·1	59·2	45·0	70·0
	„ 36	40·8	44·3	57·4	68·6	82·0	87·7	102·6	96·0	82·0	66·0	54·8	41·5	68·8

The temperatures, for each month and for the whole year, as given in this table, have been laid down on thirteen maps (Plates XIV to XVII); and lines have been drawn through places of equal sea-level temperature. The map for the year (Plate XIV), is on a moderately large scale, occupying a whole sheet; and on it, lines have been drawn for each degree: the monthly maps are on smaller scale, four to each sheet, and on these, lines have been drawn for every two degrees difference of temperature. On these smaller maps, as printed, only the more important stations are shown, but the isotherms were first drawn on larger maps, in which all the stations appeared.

On the average of the year, the hottest part of the country, over which our maps extend, is the northern part of the Deccan and Khandesh. A slightly sinuous line, running north-north-west, from Dhulia through Nemuch, Bickaneer, and Shahpur to Thull and the Kuram valley, may be called the thermal equator, or more correctly the line of greatest

temperature anomaly; west of it, except in the Aravalli and South-Ea ugh by a relatively cool region. Upper Sind and Kachh-Gandava are also relatively hot regions; while the hill country occupied by the Marris, Bugtis and other tribes, between Jacobabad and Dehra Ghazi Khan, appears to be cooler than the average of surrounding places. Unfortunately, we have no observations from this region, though troops were recently stationed, for more than a year, at Vitakri and Thull-Chotiali.

Other parts of the country, which seem cooler than the average, are the vicinity of the Gulf of Cambay, the Kaimur range and Jubbulpore region and the peshawar valley. A remarkable region of unusually high temperature is found in the Kumaun Himalaya, especially on the inner ranges, as indicated by the observations of Ranikhet, Almora and Pithoragarh. The Chutia Nagpur plateau also appears to be warmer than either the Bengal delta, Orissa, or the Sone valley.

Within India proper, between the 20th and 34th parallels, along the line of highest temperature, the mean sea-level temperature decreases from 81° to 73°F., or the average rate of decrease is about 0·7°F. for one degree [illegible] Yarkand, the decrease is about 19°F. in 18½° [illegible] *each degree of latitude. Along the meridian of 80°E. from 20° to 28°N.* the temperature diminishes from 82° to 76°F. or 0·75° for one degree of latitude.

We may therefore take the average rate of decrease for North-Western India to be about three quarters of a degree for each degree of increased latitude, while in the Trans-Himalayan regions the rate exceeds 1°F.

The relatively hot regions, above enumerated, agree in one other character—they are all regions of light rainfall; and the cool regions have all a rainfall above the average. If we assume that the temperature would diminish uniformly with the latitude, but for the influence of the rainfall, and that the further decrease is [illegible] to the amount of the annual rainfall, we may express, approximately, th any place in the plains of North-Western India, by the formula,

$$T = 88° - 0·7°(\lambda - 20°) - 0·12°R,$$

where R is the annual rainfall in inches. In Kathiawar, Cutch and Lower Sind, the temperatures are less than those calculated by the formula, because, though the rainfall of these countries is slight, the temperature is moderated by the sea-breeze.

The chief characteristics of the temperature distribution, in each month of the year, are as follows:—

January, Plate XV.—In this r [illegible] from 72·9° at Dhulia and 73·3° at Buldana to 54·4°

In Afghanistan, it ranges from 49°

Indus valley, it varies between 46° and 40°, and at Yarkand is probably below 30°.

Upper Sind, the desert between Jesalmir and Bickaneer, and the Central Punjab are relatively warm regions, notwithstanding the low temperature of the nights; while the Aravali region, the Eastern Panjab, and the middle Ganges valley, between Allahabad and Benares, together with the Kaimur range, the Sone valley and South Rewah, are relatively cool. On account of these anomalies, the isotherms, while, on the whole, following the parallels of latitude, assume a very sinuous or wavy appearance. The

greatest deviation from parallelism is in the Punjab, where the lines bend far to the north: the plains of India in winter, where protected from northerly winds by the Himalaya, being much warmer than either Afghanistan or Tibet In the Indus valley, the isotherms run nearly parallel to the river, *i. e.*, nearly north and south; the temperature of the open plains, near Dehra Ghazi Khan, Mooltan and Bhawalpur, being reduced by nocturnal radiation, quite as much as at Peshâwar, Sialkot and Lahore; though these are from two to four degrees further north.

In the Dehra Dun, and probably also in the sub-montane valleys of similar structure to the west of the Jumna, the actual mean temperature of January is almost identical with that of the plains 1,200 and 1,400 feet below, and the sea-level temperature of the Dun is consequently higher than that of the plains. The reason of this peculiarity, the same which sometimes causes an inversion of the normal variation of temperature in an anticyclone, has been pointed out at Vol. I, page 386.

February, Plate XV.—In February, the highest temperature in the part of India covered by the map, is 79·1° at Buldana; and the lowest 56·3° at Peshawar; the range being thus 23°, or four degrees greater than in January. In Berar and Khandesh, by the middle of February, there are distinct indications of the approach of the hot season; while, in the extreme north, the temperature of February differs but little from that of the previous month. In the Upper Indus valley, however, and at Yarkand, where the winter snows are inconsiderable and do not lie long on the ground, the sea-level temperature of February is 8° or 10° higher than that of January.

In Kathiawar and Cutch, the temperature rises rapidly during February, as it does in the Deccan and Khandesh; but between these two regions, round the shores of the *Gulf of Cambay, there appears to be a relatively cool area.* The observations taken at Sirsa, on the border of the desert, to the north-west of Delhi, show that the country round that station is cooler, in February, than places like Ferozepore and Umbala, which lie further north.

The banks of the Ganges near Allahabad, Benares and Chunar remain cooler than surrounding districts, throughout February; the sea-level temperature being little above 66°; while, to the north, between Rae Bareli and Azamgarh, there is a narrow zone, in which it probably exceeds 68° F.

March, Plate XV.—In March, the hottest of the regular meteorological stations in our maps is still Buldana, and the coolest in India proper is Peshawar. The sea-level temperatures of these two places are 87·2° and 66·5° respectively, the range being over 20°. At Yarkand, the temperature has risen to 55·2°. In the Himalaya and the Northern plains, the isothermal lines follow the same general directions as in the two preceding months; but, in the south, the area of highest temperature is much widened out eastwards, and includes the whole of the Berar plain as far as Nagpur.

In Western Rajputana the lines pursue a very sinuous course, which, in the absence of observations from the Khairpur, Jesalmir and Jodhpur States, must be treated as somewhat uncertain. The temperature of Hyderabad, at the head of the Indus delta, exceeds 81°, and at Jacobabad, on the Upper Sindh frontier, it is as high as 76°; while it is below 65° at Quetta. This makes the decrease of temperature, in the direction of the Bolan Pass, very rapid. Between Bickaneer, Ulwar and Jeypore, in Northern Rajputana,

the temperature, at sea-level, exceeds 80°; while, further south, at Pachbudra, Erinpura, Beawar and Ajmere, it is apparently below 78°.

On the west coast, the isotherms run as nearly as possible parallel to the coast line, each one making a bend northwards in the Gulf of Cambay.

April, Plate XV.—Parts of the Berar and Nagpur plain, in this month, have a temperature exceeding 94°, while, at Peshawar, which still remains the coolest place in India, the temperature is 74·8°. The difference between Peshawar and Buldana is now reduced below 20°, or is about the same as in January. At Cabul, the sea-level temperature is higher than at Peshawar, and at Yarkand it has risen to 78°.

The isothermal lines, in this month, are less regular than in January, February or March. The line of 92° pushes a great loop to the north-east, to include Hoshangabad and Narsingpur in the Nerbada valley. The lines of 90°, 88° and 86° are similarly thrown up to the north-east, by the high temperature of Bundelkand, the Lower Ganges-Jumna Doab and Southern Oudh; while the high temperature of the Bundelkand region culminates in a local maximum, exceeding 90°, at Jhansi. Other local maxima are found on the Chutia Nagpur plateau and Bickaneer, and perhaps also at Kherwara in Mewar The Aravali chain has a sea-level temperature below 88°, while the surrounding districts have temperatures between 89° and 90°. In the north of Kashmir and Baltistan there is probably, in this month, an area of relative cold; the snow there lying longer than in Ladakh and Rupshu to the east and south-east. On the west coast, the isotherms follow the outline of the land as in March.

May, Plate XVI.—The region of highest temperature, in this month, is shifted further to the east, the hottest place being Nagpur, with a sea-level temperature of 97°. With the exception of Bombay and Kurrachee on the coast, Peshawar is still the coolest place on the Indian plains, its temperature, in this month, being 85°. The temperature range from south to north, over 14° of latitude, is thus only 14° in May. The mountains and table-lands, which bound the Indian plains on the north, increase rapidly in temperature during May. The sea-level temperature at Cabul and Yarkand exceeds 85°, while at Quetta and Kelat it reaches 90°.

The isotherm of 96°, in the south, includes East Berar, Nagpur and the Chhattisgarh plain. To the north-west, it includes three independent areas in the Narbada valley, Bundelkand and North Rajputana; the four areas being separated by the Mahadeva hills, the Vindhya and the Aravali range. As in the preceding month, the greater portion of this latter range constitutes a relatively cool area, enclosed in a separate isotherm, which, in May, extends into south-east Rajputana as far as Neemuch. The isotherms project long loops into the Kachh-Gandava plain, the Western Punjab and the Himalayan range.

The last-mentioned characteristic is very remarkable; stations at the foot of the mountains, like Peshawar, Rawal Pindi, Sialkot and Hoshiarpur, being decidedly cooler when allowance is made for elevation, than adjacent places on and behind the first high ridge It may be supposed that the corrections for elevation applied to the temperatures for this month are too great; but the almost identical sea-level values for Roorkee, Mussooree, Chakrata and Ranikhet show that the allowance for elevation is probably not far wrong.

June, Plate XVI.—With the advent of the rains, in the early part of this month, the temperature of the west coast and Central India rapidly falls, so that the maximum temperature is no longer found in Berar, but in the great dry region to the north-west. The lowest temperature occurs at Bombay, where the mean for the month is 82·7, while sea-level values exceeding 97° are found at many places in the Punjab and Rajputana.

The isotherm of 96° encloses Quetta, Kelat, Cabul and the greater part of the Punjab and Western Rajputana; while an outlying area includes Agra, Gwalior, Jhansi and Nowgong; being probably divided from the main region, by a relatively cool zone extending through Aligarh, Muttra, Bhurtpore, Deoli and Neemuch; though this is somewhat doubtful. In the centre of the hottest region, the stations Dera Ismail Khan, Dera Ghazi Khan and Mooltan have a slightly lower temperature, perhaps owing to the influence of the irrigation canals, which begin to fill towards the end of the month.

Along the inner ranges of the Himalaya, between Pithoragarh and the Sutlej valley, the temperature is higher than on the adjacent plains; while, at Murree, there are indications of the existence of similar conditions along the western part of the range. To the north of the Himalaya, the isotherms, in June, appear to run nearly north and south; Tibet being probably still a region of relative cold, while at Yarkand and Skardo the sea-level temperatures exceeds 92°.

July, Plate XVI.—In July, the lowest temperature occurs off the Bombay coast, where it probably does not exceed 80°; while, immediately behind the ghats, in Khandesh and the Deccan, it exceeds 84°; the rainfall in this part of the country being light. Over the whole of the Central Provinces, Berar and Malwa, in the region swept by the westerly winds, the temperature averages about 83°, at sea-level; though, in the valley of the Ganges and on the Chutia Nagpur plateau, where weaker easterly currents prevail, the temperature is about two degrees higher. The highest temperature in India occurs at Jacobabad, where it reaches 95° at sea-level. At Bahawalpur, Mooltan and Dera Ismail Khan it is little less.

Both in Afghanistan and Tibet, the sea-level value of the mean temperature probably reaches or exceeds 100°F., though of this we have no direct evidence, except in the observations made during two years at Gilgit, when these are taken alone.

At Kelat and Quetta, however, it almost reaches 99°, and at Yarkand it reaches 97·5°.

The isothermal lines of this month follow, very closely, the lines of equal rainfall, a rule which is especially obvious in the Himalaya; when each isotherm throws out a long loop to the north-west, enclosing a portion of the outer zone of the mountains and the plains below; the comparatively low temperature of the Bengal plains, being thus, as it were, carried forward by the south-easterly rainy winds which blow along the sub-montane belt.

August, Plate XVI.—The distribution of temperature, in this month, is very similar to that which obtains in July, though the Indus valley is several degrees cooler. The temperature now ranges from 80°, in the vicinity of Bombay, to 92° at Shahpur in the Panjab. The Vindhya range and East Berar are relatively cool areas, while Chutia Nagpur appears to be hotter than the surrounding districts. The cool belt of the Himalaya is apparently divided into two, in August, by the Sutlej valley; while the hot and dry character of

September, Plate XVII.—In September, the isothermal lines are similar, on the whole, to those of July and August, though the temperature of the dry regions in the north and west is now much less. The lowest temperature still occurs off the Bombay coast where it is below 80°; while, in north-west Rajputana and the Punjab, there is a long oval area above 90°, and to the west of Dera Ismail Khan among the Wazeeri highlands the sea-level temperature probably also exceeds 90°.

The isotherm of 90° also includes considerable areas in the drier parts of the Himalayas; but, beyond the snowy range, the temperature now diminishes with an increase of latitude.

Among the abnormally hot regions, in this month, may be enumerated Khandesh, the Chhattisgarh plain and Chutia Nagpur; while the Vindhyas, Northern Oudh and the Sub-Himalayan districts, as far west as Peshawar, are abnormally cool. This is also the case with the greater part of the Indus valley, where the effects of the inundation canals are now fully felt.

October, Plate XVII.—In October, the distribution of temperature, which is characteristic of the cold season, begins to be restored. Buldana is again one of the hottest places on our maps, and Peshawar is the coolest in India; the temperature of these being 84·1° and 75·8° respectively, at sea-level. Beyond the Himalaya, the temperature rapidly decreases, and is probably below 60° at Yarkand.

The isotherm of 84° surrounds several detached areas, the principal one being in Khandesh and the Deccan, another in Chutia Nagpur, and a third in the centre of Rajputana. The other isotherms follow rather irregular courses, more or less completely surrounding Central India. In Kumaun and at Murree are outlying maximum regions, the former of which has a sea-level temperature exceeding 80°, while the isotherm of 78° almost completely surrounds it. In Central Oudh, is another area, with a temperature above the average of surrounding districts. The isotherm of 80° makes a long bend to the south-west, to enclose Jubbulpore and Mandla, which have the same temperature as Chunar, much farther to the north-east.

November, Plate XVII.—In this month, the sea-level temperature varies from 79·1° at Buldana to 62·1° at Peshawar, 56·2° at Quetta, and 42·8° at Yarkand.

Off the Bombay coast and in the Gulf of Cambay, the temperature probably exceeds 78°.

South-east Rajputana and Malwa are three or four degrees warmer than the Nerbada valley and Rewah; consequently, the isotherms of 76°, 74° and 72° push themselves far to the north-east in Rajputana, Central India and Bundlekand and then sweep back to the south-west in the Nerbada valley. The temperature of the Kumaun hills remains high, in comparison with that of the plains of Pilibhit and the Tarai, where fogs are of frequent occurrence in the forenoons.

December, Plate XVII.—In the last month of the year, which is usually almost as dry as November, the distribution of temperature resembles that of November more closely than it does the distribution which obtains in January; though the decrease with increase of latitude is more rapid than in November, and the temperatures, on the average, are several degrees lower. The highest temperature, 74·8°, is now found on the Bombay coast; while, at Peshawar, the sea-level value is 52·9°, the difference being thus 22°, or four

the same difference of latitude, nearly equal to that of January. At Quetta, the temperature is only 50°, and at Yarkand it is little over 30°F.

Malwa is still a relatively warm region, while the north-eastern part of the Central Provinces and Rewah are cool. The dry districts west of Delhi constitute a cold area, of which the centre lies near Sirsa. The lower districts of the North-Western Provinces are also cooler than the northern districts or the country south of the Ganges. In the Himalaya, where little snow falls until the end of the month, the inner ranges of Kumaun and Garhwal, the Kangra valley and the vicinity of Murree are warmer than the surrounding country.

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